THURSDAY, FEBRUARY 7, 1901.

A NEO-DARWINIAN ON EVOLUTION.

Problems of Evolution. By F. W. Headley. Pp. xvi + 373. (London: Duckworth and Co., 1900.)

MUCH of the work that has lately appeared on the subject of organic evolution has been characterised, if not by a misapprehension of the main points at issue, at any rate by a want of due proportion in the treatment of data, and by a tendency to build an elaborate superstructure on a very slender foundation of fact. This applies less to the work of English authors than to those of other countries. It is satisfactory to find that English men of science, who have always taken a leading part in the promotion of sound and rational views on the methods of evolution, are still distinguished by the thoroughness and good sense which they bring to bear on the discussion of evolutionary problems.

Mr. Headley's book is on the whole a favourable example of this kind of literature. It is true that his statements of fact are not always free from error, nor are his arguments on all points convincing; he shows, nevertheless, a just appreciation of the difficulties of the subject and a wide acquaintance with the various attempts that have been made towards their solution, while his own suggestions have been well considered, and are often of distinct value. His standpoint is more thoroughly Darwinian than that of many other recent writers, and in him the principle of natural selection as the most important factor in evolution finds a powerful and skilful advocate. He is an uncompromising opponent of Lamarckism, and one of the most satisfactory sections of the book is that in which he shows how completely the Lamarckian principle fails to account for those very phenomena which have been most confidently appealed to in its support. This, however, does not preclude him from recognising the importance of the suggestion made independently by Profs. Mark Baldwin and Lloyd Morgan, viz., that the selection value imparted to a congenital variation by exercise may enable such variation to become the starting-point for other variations in the same direction (Darwin's "Continuity of Variation"). Not only does he adopt the principle in the form here stated, but he goes on to show that parental care and the gregarious habit may act in a similar way by promoting the survival of certain characters which can be increased by practice, and so giving an opportunity for their enhancement, by further variation, in successive generations. But he rightly points out that this cannot properly be claimed by Lamarckians as a concession to their views; those who would so claim it must have, as he says, "a singular power of mistaking an utter rout for a compromise." For, as Prof. Lloyd Morgan makes clear, there is here "no transmission of modifications due to individual plasticity"; and what really emerges is that natural selection is capable, without such transmission, of doing all that was exclusively claimed on behalf of Lamarckism.

On the defensive side, Mr. Headley makes a forcible use of the phenomena of adaptation. He has little to bring forward that is actually new on this head, but his statement of the case is a clear and cogent one. The principle of recognition marks is acknowledged by him as supplying the key to many instances of apparently useless characters, and this line of argument might profitably have been expanded. He is on strong ground when asserting the importance of slight points of difference.

"Two races are brave beyond dispute, but one will stand a little longer under fire than the other, and it is this little that makes all the difference in the struggle. Two young men are about on a par, and seem likely to run neck and neck in the race of life, but an almost imperceptible superiority in one seems to act with cumulative effect, and in twenty years, say, he is miles ahead."

The latter illustration will appeal to most readers with experience of life.

The author's treatment of the important subject of variation is interesting and suggestive. True to his anti-Lamarckian principles, he denies any direct influence of the environment on the origin of variations properly so-called: "An external condition can do nothing but bring to light some quality" already latent. To explain the variations among offspring we must fall back on the doctrine of the continuity of the germ-plasm coupled with the specialising effect of cell-division.

"When fission takes place, inequality must result. . . . There is a thorough shuffling of the cards before they are cut."

This view is to some extent akin to Weismann's earlier position as to the import of reducing divisions and amphimixis. But the author goes further than Weismann. Not only have the reducing divisions of the germ-cells in the metazoa the value of an incipient specialisation, but the simple fissions of the protozoa have precisely the same significance. Over-specialisation, such as would in many cases result from a process of fission indefinitely continued, is a cause of failure and death. This in the bulk of the protozoa, at all events, is counteracted by periodical conjugation, which tends to restore to each cell some elements which it had lost, or was in process of losing, by repeated fission. Amphimixis in the metazoa has a similar *rôle*. Hence both fission and conjugation, or amphimixis, are a cause of variation, though the latter, while increasing the possibilities of deviation, tends to prevent it from taking a harmful direction. An obvious criticism on this view is that two imperfect organisms do not necessarily make a perfect one. The speculation, nevertheless, is ingenious and interesting, even though it may fail to convince.

In a further discussion of that perfection of adaptation which almost appears to call for a "directive force" presiding over variation, he takes occasion to give an account of Prof. Weldon's application of the law of chance. The argument is fairly stated, but in his comments upon it Mr. Headley seems disposed to blame Prof. Weldon's results for not clearing up points with which they were never intended to deal. His criticism is thus somewhat beside the mark, for, as he himself admits, Prof. Weldon's aim was chiefly to demonstrate the high probability of advantageous variations affecting a large number of individuals at the same time, in this way affording abundant material for selection. The question why variation should take one direction more than another belongs to

a distinct line of inquiry. In framing his own answer to the question, the author lays stress on the controlling power of heredity, on Darwin's principle of "continuity of variation," or, as he prefers to call it, "sequence of variation," and also on the fact that the variations of the organic environment of a species—the several other species, that is to say, with which it has to keep *en rapport*—being subject to similar limitations with its own, are not likely to set it an impossible task in the way of providing fresh adaptations. Moreover, there are usually periods in the history of a species when it has, as it were, a choice of environments, so that the possibilities of adaptation open to it are enlarged. This latter position might well have been illustrated by the striking case of certain mimetic butterflies; amongst which it is often found that species closely allied to one another, and sometimes even the two sexes of the same species, have been drawn apart, so to speak, into separate protected colour-groups; while still other species of the same affinities occupy intermediate positions, ready, as it were, to throw in their lot with this or that colour-combination, according to their needs. The upshot of the author's contention as to variation and adaptation is, that while the range of possible variation is not indefinite, but necessarily limited, the limitation is in no sense due to the direct action of the environment; still it is this very limitation that renders adaptation possible, by ensuring a supply of such material as is capable of being moulded by the selective action of the existing external conditions. Variation that took place merely at random, were it conceivable, would almost inevitably consist of all misses and no hits.

In the second and concluding part of the book, Mr. Headley deals with the application of evolutionary doctrine to the problems of human development. His treatment of this part of the subject, as of the other, shows freshness, vigour and ability; but he could here hardly avoid raising points of a highly controversial character, and most of his conclusions are likely to be sharply assailed. Adopting in many respects the point of view of Mr. Benjamin Kidd, he discusses at length the origin and influence of the moral sense, and the various conditions that with advancing civilisation tend to defeat or delay the operation of natural selection. The antagonism between altruism and the "cosmic process," which was adumbrated by Huxley in his memorable Romanes lecture, receives a careful and extended treatment; and the author states his own conclusion somewhat as follows:—The development of human intelligence has in many ways checked the wholesome operation of natural laws. Being capable of exercise in anti-social directions, it has in times past threatened the well-being if not the very existence of the race. From this fate humanity has so far been preserved by the practice of altruism under the sanctions of religion and morality. Supposing this first peril to have been successfully met, there remains the further danger of physical degeneration, which may presently become imminent, and the proper treatment of which is among the most important problems that await us. In spite of his indictment of human reason, Mr. Headley is no pessimist. So far from having lost confidence in the future of the race, he looks boldly to the old sanctions, under higher and more enlightened forms of application, to save the human species from physical, as they already have from social disintegration. It is obvious that the working out of this idea, which indeed is not attempted by the author himself in any detail, involves considerations which are unsuitable for discussion in a notice like the present. Suffice it to say that Mr. Headley does not write at random; and that his views challenge attention, whether sympathetic or otherwise.

Notwithstanding an occasional abruptness and jerkiness of style, the author writes well and expresses his views with clearness. More care might with advantage have been bestowed on the proofs; misprints are not uncommon, the punctuation frequently leaves much to be desired, and there is a curious lack of uniformity in the use of scientific names. Some questionable palæontology will be found on p. 105, and some equally doubtful pathology on pp. 246, 247. An inaccurate use of the term "chrysalis" may be noted on p. 59. But in spite of these and other failings the book reaches a high standard of merit, and should appeal to a wide circle of general readers besides those more especially conversant with the subjects of which it treats.

F. A. D.

THE CENTURY OF SCIENTIFIC PROGRESS.

The Story of Nineteenth Century Science. By Henry Smith Williams, M.D. Pp. x + 476. Illustrated. (London and New York: Harper and Brothers, 1900.) Price 9*s*.

THE story is worth telling, for whatever the ages may hold in store they can hardly deprive the nineteenth century of the distinction of having witnessed a progress in science without a parallel in the earth's history. Each step in advance has served as a starting-point for many others, and the record of the last quarter century, even of the last decade, far surpasses that of the corresponding period at the outset. The opening chapter of this book, "Science at the Beginning of this Century," enables us to realise how immense the gain has been.

To write such a history is a task on which, at the beginning of the century, an author might have entered with a light heart. Now such an undertaking seems almost an audacity. Scientific omniscience has long become impossible; but in an age of such rapid progress something of the kind is required for a work like this. The reviewer is in a still worse plight. How can he—probably almost wholly occupied in trying to carry some one road a little farther into the unknown land—be competent to decide whether the author has done full justice to those similarly engaged in other directions? So I shall speak critically only of my particular subject, and for the rest briefly touch upon the salient features in the author's narrative. The book, I may remark, evidently had its origin on the other side of the Atlantic, so that the illustrations have a slightly American tinge. The same also may sometimes be said of the English. As example, "down" is a new verb to us; "per hypothesis" jars on the ear; to say that a man was "then only a novitiate in science," startles any one accustomed to employ the word novice. Such solecisms, however, are but few. The chapter on palæontology seems oddly placed between

those on astronomy and geology—surely this, as regards the latter, is a "cart before horse" position. It is also widely separated from biology, with which it is no less closely connected.

We turn, then, to geology, which a century ago could hardly claim to be a science. We find a clear sketch of the principal advances, with some particulars about those who made them, and only in a very few cases are we inclined to dissent. To say that the "strata are level" in the mountains of Sicily [and] the Scotch Highlands is doubtful, unless we are rather liberal in using the term mountain, and is true of only a small portion of the latter region. In speaking of the joint work of Murchison and Sedgwick, the author fails to mention the Cambrian system, and thus does an injustice to the man who independently and accurately established its position. In regard to the Laurentian system, we think that the statement "they are now more generally regarded as once-stratified deposits metamorphosed by the action of heat" would have been truer twenty years ago than at the present time, for the majority of these rocks, we think, are now more commonly considered to have had an igneous origin. While we believe, with the author, that uniformitarian creed must not be so enunciated as to exclude a certain "slowing down," we should hesitate to assert that in any known era

"large areas were rent in twain and vast floods of lava flowed over thousands of square miles of the earth's surface, perhaps at a single jet; and, for aught we know to the contrary, gigantic mountains may have heaped up their contorted heads in cataclysms as spasmodic as even the most ardent catastrophist of the elder day of geology could have imagined."

But with a crust much thinner than it has been in later geological ages, fracture would be more easy and catastrophic disturbances less intense, because more frequent. At any rate, the facts of geology, so far as we can remember, do not support this statement, and Lord Kelvin, who is quoted in its favour, once used the simile of the last spurt of a cooling porridge pot to indicate that, owing to the greater resistance of the crust, a local catastrophe might be as severe in a late age as in an early one. Again, we demur to the following statement—if the author is speaking of any known geological age—that the constituents of the early atmosphere "have since been stored in . . . granite." Unless we admit it to have cooled on the earth's surface, how could this rock plunder the atmosphere? But *Ubi plura nitent . . . paucis offendar maculis?* The author gives a clear sketch of the progress of geology and palæontology from infancy to adult manhood. The principal stages of growth are described, even youthful escapades, the age of which is not yet ended, are sometimes chronicled. But for the most part he restricts himself to those hypotheses which have been able to stand the test of time and are now more or less promoted to the dignity of theories.

But the advances in terrestrial and celestial physics have been even more surprising. With the spectroscope to investigate and the camera to record, each being a discovery of this century, sun, stars, comets and nebulæ are yielding up their secrets; the existence of the ether, the nature of light, the relations of the physical forces, are demonstrated—nay, the genesis of worlds and of matter itself are becoming themes for discussion, while immense advances have been made in chemistry and meteorology. The same is true of the biological sciences, which have been almost revolutionised since the appearance of the "Origin of Species," little more than forty years ago. Though, as these pages prove, no one would assert that the last word has been said on evolution, the process, however it may be explained, is a fact, and its consequences have already extended far beyond biology.

The advance is not yet ended. In proof of that we need only point to the marvels of the Röntgen and Becquerel rays—discoveries of the last decade. Problems enough await solution in this century, of which an excellent summary will be found in the concluding chapter. Unless some dark catastrophes await civilisation, like that triumph of savage ignorance which boasted that "the republic has no need of *savants*," many secrets of nature should be discovered before the new century has run its course. Matter, force, energy, life—what problems these four words suggest, perhaps in part inscrutable—but still, even of these our descendants should know more than the wisest of our own age.

Dr. Williams has produced an interesting book, the more so because it is liberally illustrated with portraits of the leaders of science. These, though unpretending, are often good likenesses, the other illustrations being of a more commonplace character. This volume, like White's "Warfare of Science," should be a manual in every course of theological instruction, because the history of the progress of science declares how it has been opposed, in the imaginary interests of religion, by the friends of the latter. In the past the geologist, the biologist, the physiologist have been vituperated and denounced by ignorant champions of theology, whose fears and assertions time has proved equally unfounded. The mistakes of their forefathers will be a lesson of caution to coming generations; for the spirit of ecclesiasticism is not yet extinct, and our successors will have to confront old foes, though perhaps with new faces.

T. G. BONNEY.

VAN 'T HOFF'S PHYSICAL CHEMISTRY.

Lectures on Theoretical and Physical Chemistry. By J. H. van 't Hoff. Translated by R. A. Lehfeldt. Part iii. Relation between Properties and Composition. Pp. 143. (London: Edward Arnold, no date.)

Leçons de Chimie Physique. Par J. H. van 't Hoff. Ouvrage traduit de l'allemand par M. Corvisy. Troisième partie. Relations entre les Propriétés et la composition. Pp. ii + 170. (Paris: A. Hermann, 1900.)

THE English and French translations of the concluding part of van 't Hoff's lectures are now before us. Although this part ostensibly deals with the relations between properties and composition, its scope is really wider than its title, for it includes the discussion of colligative properties, which are not related to composition at all.

The first third of the book is chiefly concerned with volume, pressure and temperature relations as deduced from van der Waals's equation and the critical constants. As a feat of terse and lucid exposition, this section is unequalled in any text-book with which the present

writer is acquainted. The subject is not an easy one, and the reader must bring a certain concentration of thought to its study; but once he has mastered these forty odd pages he will know the bearing of the critical phenomena on physical chemistry with a thoroughness that will leave little room for addition in his subsequent reading, except on matters of detail. The work of Young, Guye, Daniel Berthelot, Mathias, Guldberg, Traube—all receives consideration, and the impression left is one of harmony and completeness, at least from the practical empirical standpoint.

Boiling-points, latent heats and specific heats are next taken up, and the student will be surprised at many a new way of looking at old familiar facts. Under the heading of surface tension, the method of Eötvös and Ramsay and Shields for determining molecular weights is fully discussed, and a theoretical connection shown with Mathias's law of the rectilinear diameter. The section on physical properties concludes with a chapter on refractive indices and dielectric constants.

The second portion of the book is entitled, Relations between Chemical Properties and Composition. Its first subdivision treats of the affinities of elements as displayed in connection with their positive or negative character. The author's views on this important general question are summarised thus: Positive or negative character is defined as the tendency to combine with positive or negative electricity. The extreme positive and negative elements, such as sodium and chlorine, show the strongest affinities, which suggests that their opposite electrical charges play an active part in their chemical combination. Intermediate elements which are neither decidedly positive nor negative, *e.g.* carbon, often show a tendency to combine with themselves which is wanting in the extreme elements. As second consequence of the tendency to combine with electricity, we have the free production of atoms charged with electricity—the ions—in solvents like water which weaken the electrical attraction owing to their high dielectric constant. This breaking up or loosening in its turn entails a facility for reaction which is absent from intermediate elements, carbon compounds, for example, being characterised by great inertness in chemical action. Lastly, the phenomena of affinity are most marked when the atomic weight is small and the atomic volume large.

A study of the affinities manifested by explosive compounds and explosive mixtures is next entered on, and then the influence of the separate elements on the properties of compounds which they enter is taken up in detail. The concluding sections are on the changes in reaction velocity caused by certain elements and groups, and the appearance of entirely new chemical properties occasioned by the conjunction of certain elements.

On looking back through the book as a whole, one notes the circumstance that Parts i. and iii. are better done than Part ii., and that, on the whole, the physical portions are perhaps at a higher level of excellence than the chemical portions. It is everywhere evident, however, that the material has been wrought into form by a powerful thinker, who sees deeper and more clearly into his subject than any of his contemporaries.

A comparison of the English and French translations shows that the former, being more literal, is more difficult to follow than the latter. The freedom of translation in the French version is, however, not attained at the expense of accuracy; indeed, in more than one passage the sense of the original is better given in the French translation than in the English. To translate *dann* by "therefore" or even by "then," when it is merely used for the purpose of enumerating points of the argument (as in p. 89 of the original, and p. 98 of the English version), gives a false impression of logical sequence; and to translate *Affinitätsäusserungen* by "indications of affinity" (same page) is scarcely exact.

To the French version are appended two notes by the translator—one on Dieterici's modification of van der Waals's equation, the other on Kanonnikoff's "real density," derived from the formula of Lorentz and Lorenz.

Whilst strongly recommending the English version to all interested in physical chemistry, the writer would express the hope that in a future edition the three parts will be paged and bound as one volume, that the price will be reduced to a figure more suited to the size of the work and the means of the majority of students, and, finally, that the book will be provided with an index, the want of which in the present edition materially detracts from its usefulness.

J. W.

NEW MAPS AND ATLASES.

The "Diagram" Series of Coloured Hand Maps. Designed by B. B. Dickinson, M.A., F.R.G.S., and A. W. Andrews, M.A., F.R.G.S. (London: George Philip and Son, 1900.). Price 1*s.* per dozen maps.

Philips' London School Board Atlas. Edited by G. P. Philip, Jun., F.R.G.S. Pp. 36. (London: G. Philip and Son, 1900.). Price 1*s.*

The London School Atlas. Edited by H. O. Arnold-Forster, M.A. Pp. 48. (London: The London School Atlas Co., Ltd., 1900.). Price 2*s.*, 3*s.* and 3*s.* 6*d.*

GOOD maps are essential to the success of geographical instruction. The best method of obtaining a true knowledge of the relation of the various land and water surfaces of the earth to one another, their relative dimensions, and their distribution in latitude and longitude, is by the use of a good terrestrial globe; but maps are indispensable even when globes are used, for they show in detail what can only be represented upon a small scale on a globe of the size used in schools. Each of the collections of maps, the titles of which are given above, has its good points, and all of them will assist in the intelligent teaching of geography.

The coloured hand maps prepared by Messrs. Dickinson and Andrews are the best orographical maps suitable for school use which have come under our notice. No names are printed upon the maps, but the elevations of the country are represented in five or six grades of colour, and the chief rivers are inserted. With maps such as these before him, a pupil can see at once how the general direction of river flow is determined by difference of level. He can, for instance, follow with intelligent interest the courses of the Ganges and Brahmaputra Rivers from the Himalayas down to their delta and the Bay of Bengal. The grades of colouring of

different levels of land show clearly that the directions taken by these rivers are the only possible courses for water running downwards to the sea. The course of the Amazon and its tributaries across South America can similarly be understood by a glance at the orographical map. There are thirty maps of this kind in the series, and they are uniform in excellence. They thus bring out prominently the importance of land elevation, and used as they are intended to be—for pupils to fill in the details of physical, political and commercial geography—they will be of real educational value. In the absence of relief or contour maps, the "Diagram" series of orographical maps provide an admirable introduction to the study of geographical science. To convey the idea of comparative size, Great Britain or the British Isles is represented in one corner of each map on the same scale as the map itself. The maps can be supplied as lantern slides, as well as in several forms suitable for school requirements.

Among the noteworthy characteristics of Mr. George Philip's atlas are its remarkable cheapness—the price is only 1*s.*—and the selection of important geographical features to which prominence is given. There are in the Atlas forty coloured plates, containing ninety maps and plans, and eight pages of introductory letterpress. Physical features are clearly represented, and the scale is stated under each map. The difficulty of distinguishing between political boundaries and lines bordering physical features has been successfully overcome by printing the former in distinct red lines. The maps have not the common defect of being overcrowded, and they are up to date both as regards the spelling of names and political divisions. To ensure that the pupil understands the meaning of a map, several views and plans are given side by side; and there are also maps of the County of London and the Thames Basin. These special supplementary maps can be modified to suit local requirements. There is no excuse for using obsolete maps filled with confusing and unnecessary details now an Atlas such as that by Mr. Philip is available.

The Atlas edited by Mr. Arnold-Forster is constructed upon the same intelligent principles as the preceding one; the maps are well drawn, beautifully coloured, not overcrowded, and the place-names have been carefully selected. Views, plans and sections are shown under one another in the introductory maps to provide lessons in map reading. There are also maps of the same district on different scales, illustrations of methods of showing elevation, as used in Ordnance Survey maps, and a reduced Admiralty chart of the Needles to show the method of sea-mapping. Several good astronomical diagrams show some of the phenomena connected with the rotation and revolution of the earth, but Map 8 is incorrectly designated the Solar System; for all that comes under this head in it are the earth in its orbit at the equinoxes and solstices, and the lines representing the relative lengths of the diameters of the sun, earth and moon. Following these maps are forty others upon which the various continents and countries of the world are represented according to their physical features or political divisions. Several maps are devoted to the representation of the growth of the British Empire. Dr. A. J. Herbertson contributes some notes on the construction and reading of maps, and teachers will learn from them how the Atlas can best be used and appreciated.

The appearance of these Atlases at about the same time indicates, we hope, that more careful attention is to be paid to instruction in geography in the future than is now given in most schools. The maps represent the best that have yet been prepared at a low price for use by individual pupils, and their adoption can be recommended to all teachers of geography.

OUR BOOK SHELF.

Die Photographie im Hochgebirg. Von Emil Terschak. Pp. xv + 87. (Berlin: Gustav Schmidt, 1900.)

IN this neat little book of some 90 pages, the author gives the reader some practical hints, both in word and illustration, as to the road to success in mountain photography. The hand camera is now so generally used, owing to the rapidity of modern lenses, and there are so many of us who like climbing, and who always carry one of such instruments on our tours, that such a book as this, full of practical hints, will be welcomed. Mountain photography is quite an art in itself, and he who is a good picture-maker near the sea level does not necessarily meet with success when some thousand feet or so up. The effects to be portrayed at that height are of quite a different nature. There we have great contrasts of rock and sky, clouds lying at our feet, mists hanging about different hill-sides, and snow-capped peaks and glaciers adding to the beauty of the landscape.

Each of these cannot be immediately reproduced on the photographic plate without either a great experience in the class of work, or a careful study of the labours of others. In this book the author brings together in an enticing manner the chief points to be borne in mind when making a tour. He commences with useful information relative to the packing up of the camera, plates, &c., and then in turn treats of the several conditions under which the photographer is likely to work—such as photographing mountains from a valley or *vice versâ*, mountain groups from a height, clouds, mists, &c. The author accompanies his remarks with numerous excellent reproductions from his own negatives, and in every case gives data, such as the kind of plate used, lens, stop, length of exposure, time of day and year. Every one who is familiar with the German language, and is interested in mountain photography, will be sure to find this a serviceable book.

An Introduction to Vegetable Physiology. By J. Reynolds Green, Sc.D., F.R.S., Professor of Botany to the Pharmaceutical Society of Great Britain. Pp. xx + 459. (London: J. and A. Churchill, 1900.)

ONE of the needs most widely felt in modern botanical literature has been that of a good intermediate book dealing with vegetable physiology. Although several standard works dealing with this branch of botany are already in existence, they are for the most part of too advanced a character to be of much use to a junior student. It is a matter for gratification that the task of providing such a treatise should have fallen into such good hands as those of Prof. Green, by whom, as might have been expected, the subject-matter has been skilfully handled and admirably illustrated. By wisely avoiding excessive detail, and by duly emphasising from different points of view the various matters of special importance, the author has succeeded in producing a really excellent student's book, whilst the general reader will find the principal topics of current physiological interest presented in a lucid and interesting manner.

Of course it is not to be expected that such a work should be altogether perfect, and if we indicate some of the points which strike us as susceptible of improvement, we do so in the hope that the work may gain still further in value when future editions are called for.

Whilst many of the illustrations are distinctly good, some are very much the reverse, and as an example of the latter class Fig. 40 may be cited, which is excessively bad, and can hardly be said to illustrate the text (which it certainly does not adorn) in any sense whatever. The story of the digestive functions attributed to the leaves of *Lathraea* is now generally discredited, and might as well have been omitted from the text, whilst the somewhat teleological explanation of the red colour in leaves perhaps might at least have been accompanied by suggestions as to the proximate causes of its appearance such as are indicated by Overton's recent experiments. It is, however, against the short chapter on the influence of the environment on plants that we incline to take the greatest exception. The subject is a large one, and can only be adequately, or even usefully, treated by the aid of copious illustrative examples, without which as in the present instance it is apt to degenerate into rather senseless cramming.

Apart, however, from what after all are but minor and easily remedied faults, the book is, as we have already said, a decidedly good one, and its author has displayed such excellent judgment in the selection of his materials in order to meet the special needs of the class of readers for whom it is primarily designed that there will in future be no excuse for that neglect of vegetable physiology which is at present but too common with junior students of botany.

J. B. F.

A Text-book of Important Minerals and Rocks, with Tables for the Determination of Minerals. By S. E. Tillman, Professor of Chemistry, Mineralogy and Geology, U.S. Military Academy, West Point, N.Y. Pp. 176. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1900.)

IN this little manual, Prof. Tillman has brought together such fundamental instructions as are necessary to enable a beginner to determine the most commonly occurring minerals and rocks. Three short chapters on crystallography, the chemical characters, and the physical properties of minerals are followed by a series of tables for the determination of 135 common species. In the choice of these species a considerable amount of judgment is shown, though it is obvious that the opinions of an American mineralogist as to what should be regarded as the most important species differ from those of workers in Europe. The tables are on the familiar plan of those of Weisbach, Persifor Fraser, Brush and Penfield, and other well-known authors, and the arrangement adopted is a very simple one. The twenty pages devoted to rocks at the end of the volume are only sufficient to enable the author to give a very slight sketch of petrographic science. The work is worthy of the attention of teachers organising a system of very elementary instruction in determinative mineralogy.

Laboratory Companion for Use with Shenstone's Inorganic Chemistry. By W. A. Shenstone, F.R.S. Pp. vi + 117. (London: Edward Arnold, 1901.)

MR. SHENSTONE'S course of work in inorganic chemistry was noticed in these columns a few weeks ago (January 10, p. 249). Most of the experiments in that book are reprinted in the present volume, together with a number of exercises, and other experiments have been added. A volume suitable for use as a laboratory manual, that is, containing directions and suggestions, without theoretical considerations, has thus been produced. On p. 117 reference is made to a frontispiece showing Fraunhofer lines, but the picture has been omitted.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

A Compact Method of Tabulation.

IN arranging tables of successive values of a variable quantity, it is often difficult to find a middle course between making the entries too numerous and making the intervals too large. I wish to call attention to a mode of tabulation which, although compact, provides facilities for the accurate deduction of intermediate values.

For convenience of description we may regard the tabulated values as equidistant ordinates of a curve. If the common distance is small enough (which implies that the number of ordinates is large), intermediate values can be deduced by the ordinary method of "proportional parts"—in other words by employing first differences only. If the number of ordinates is diminished by largely increasing the common interval, it becomes necessary to take account of differences higher than the first. We shall suppose the interval to be so chosen that the first three orders of differences—and no more—require to be considered.

A table showing the given values accompanied by three columns of differences presents a formidable aspect; and on the other hand, if the user of the table is left to compute these differences for himself, his labour is materially increased. What I wish to point out is that, without any sacrifice of accuracy, the first and third orders of differences can be omitted, the second only being retained; as in the following table of sines, which is suitable for computing the sine of any angle to four places of decimals. The differences entered opposite the sines are the "central" second differences; for example, −104, which stands opposite to sin 20°, is (sin 30° − sin 20°) − (sin 20° − sin 10°).

Angle	Sine	Second difference	Angle	Sine	Second difference
0°	·0000	− 0	50°	·7660	− 232
10	·1736	− 52	60	·8660	− 263
20	·3420	− 104	70	·9397	− 286
30	·5000	− 152	80	·9848	− 299
40	·6428	− 196	90	1·0000	− 304

Let $u_0\ u_1$ be any two consecutive tabulated ordinates (sines) between which it is desired to interpolate a new ordinate u; $x_0\ x_1\ x$ being the corresponding abscissas (angles). Putting h for the common interval $x_1 - x_0$, let p stand for $\frac{x - x_0}{h}$, and q for $\frac{x_1 - x}{h}$, so that $p + q = 1$. Also let $u_0''\ u_1''$ denote the central second differences of $u_0\ u_1$ respectively. Then it can be shown that the value of u true to third differences is

$$p u_1 + \frac{p(p+1)(p-1)}{1\,.\,2\,.\,3}u_1''$$
$$+ q u_0 + \frac{q(q+1)(q-1)}{1\,.\,2\,.\,3}u_0''.$$

The sum $pu_1 + qu_0$ of the two terms in u_1 and u_0, though it does not put first differences in evidence, really includes them, and is the exact value of u when the connecting curve is a straight line. In like manner, though third differences are not in evidence, they are implicitly contained in the sum of the two terms in $u_1''\ u_0''$.

The coefficients of $u_1''\ u_0''$ are identical in form, and are easily computed. The following list of their values for each tenth of an interval will serve to check mistakes. Their values (neglecting sign) are always less than ·065.

$$\frac{p(p+1)(p-1)}{1\,.\,2\,.\,3}$$

p		p		p	
·1	− ·0165	·4	− ·0560	·7	− ·0595
·2	− ·0320	·5	− ·0625	·8	− ·0480
·3	− ·0455	·6	− ·0640	·9	− ·0285

Two examples will show the working of the method.

To find sin 36°, we have $p = \cdot 6$, $q = \cdot 4$.

$$\begin{aligned} \cdot 6\ (\cdot 6428) &= \cdot 38568 \\ \cdot 4\ (\cdot 5000) &= \cdot 20000 \\ \cdot 064\ (\cdot 0196) &= \cdot 00126 \\ \cdot 056\ (\cdot 0152) &= \underline{\cdot 00085} \\ & \quad \underline{\cdot 58779} \quad \text{say } \cdot 5878. \end{aligned}$$

To find sin 72° 30′, we have $p = \frac{1}{4}$, $q = \frac{3}{4}$, giving $-\frac{5}{128}$ and $-\frac{7}{128}$ as the coefficients of $u_1''\ u_0''$. Hence we obtain

$$\begin{aligned} \tfrac{1}{4}\ (\cdot 9848) &= \cdot 2462 \\ \tfrac{3}{4}\ (\cdot 9397) &= \cdot 70478 \\ \tfrac{5}{128}\ (\cdot 0299) &= \cdot 00117 \\ \tfrac{7}{128}\ (\cdot 0286) &= \underline{\cdot 00156} \\ & \quad \underline{\cdot 95371} \quad \text{say } \cdot 9537. \end{aligned}$$

Both these results are correct to the last figure.

The formula of interpolation here employed (which can be carried to higher terms when necessary) seems to be new. I gave it to Section A at the last meeting of the British Association, and have illustrated its use more fully in the *Journal of the Institute of Actuaries* for last month (January). It will also appear with other kindred matter in the next number of the *Quarterly Journal of Mathematics*. J. D. EVERETT.

Frost Fronds.

ON the morning of January 29, as I was walking from this place down Haverstock Hill into London, about 9.30, my attention was attracted by the "frost fronds" on the flags of the footpath. I see instances not unfrequently, and have called attention to one variety, where they form divergent groups, like the sticks of a partly opened fan, resembling the well-known crystals of actinolite obtained on the southern side of the St. Gothard Pass (see *Proc. Roy. Soc.* lxiii. p. 217, and *Quart. Journ. Geol. Soc.* liv. p. 368); but those now mentioned were characterised by unusual delicacy and grace. They formed groups, often half a yard in diameter, composed of frond-like radiating tufts, made up of thin stems or acicular crystals (often some four inches long and about the thickness of a bodkin) beautifully curved: this almost invariable bending of the "blades" being the most marked characteristic. They resembled very delicate seaweeds, dried and displayed on a card as an ornamental group. In descending the hill I observed that the crystals became a little coarser and more like those already mentioned. Also that sometimes clots of frozen mud appeared near the junction of the fronds, as if a trefoil or quatrefoil leaf had been placed there to hide it. I attribute the unusual delicacy of the fronds to the fact that the previous evening had been showery, and so the pavement had been cleaned of all but the very finest mud, after which had come a drying wind and a frost. Thus crystallisation probably occurred in a very thin film of slightly turbid water and on a fairly smooth surface, so that opposition to it was comparatively slight and the circumstances approached more nearly to the crystallisation of water on glass. I could not linger to make a minute study as I was pressed for time, but write this in the hope that some one who can take photographs (which I cannot) will collect examples of "frost fronds," for I believe they would be helpful in interpreting crystal building in rock masses. T. G. BONNEY.

23 Denning Road, Hampstead, N.W., January 31.

The Total Solar Eclipse of May 17–18.

THE Board of the Koninklijke Natuurkundige Vereeniging at Batavia has applied to the Government in regard to the custom duties to be levied from scientific observing parties who may visit the Dutch colonies for the observation of the total solar eclipse on May 17–18. The following reply has been received.

No duties will be levied on goods not exempted by the tariff, but destined to be re-exported after the observation of the eclipse has been concluded; observing parties may obtain further information from the chief Custom House officer at the port of arrival.

Besides all possible facilities in having their goods imported, exemption from search will be afforded to scientific expeditions.

We feel much pleasure in bringing the above under the notice of intending observing parties. J. J. A. MULLER.

January 1. (President of the Kon. Natuurk. Ver., Batavia).

The Museum of the Institute of Jamaica.

IN connection with your items regarding the possible return of Dr. J. E. Duerden, curator of the Jamaica Institute Museum, to England, may one who has spent two summers in Jamaica engaged in zoological research, and who has enjoyed the hospitality of Dr. Duerden and other men of science there, be permitted to say a word as to the causes which have led to the present unfortunate situation? There are two such principal causes, I believe, not closely related, but in this case working together toward a common end. The most important of these is local jealousy, against which Dr. Duerden has had to contend constantly ever since his arrival at the island. At the time he was appointed, a large and influential element among the supporters of the Institute desired the appointment of a young Jamaican, who had received some training in England, and who was doubtless well qualified for the duties of the position. His failure to secure the office was a bitter disappointment, not only to himself, but to his friends, and Dr. Duerden entered on his duties with an unfortunately large number of hostile critics, watching for opportunities to find fault. It is very possible—in fact, since Dr. Duerden is human, it is highly probable—that opportunities for criticism arose, and possibly the criticisms have not always been met in the wisest possible spirit. But it is clear to me, and I think I can speak for all the Johns Hopkins men who were in Jamaica, that if Dr. Duerden's local critics had been as anxious to help him and build up the museum as they were to find fault, there would be no trouble at the present time. I do not mean to say that Dr. Duerden has been entirely blameless, but I feel sure that his responsibility for the trouble is very much less than that which rests on his critics. The fact that Dr. Duerden is a trained investigator, and has given a large share of his time to research work, has given opportunity for criticism from those who believe the curator ought to devote his time to adding new specimens to the exhibition collection and labelling them all properly.

The other cause of the proposed retrenchment is one which appeals to me strongly, and must, I think, to all unprejudiced persons who know the facts. The colonial expenses are greater than the income, and the debt is already heavy. A very large proportion of the expense account is made up of salaries paid the English civil officials, from Governor down. The Governor receives a salary of 6000*l.*, besides two residences and the usual perquisites of his position. This salary is grotesquely enormous under the circumstances. Jamaica is not only a delightful place to live in, a veritable paradise in many respects, but it is a very cheap place as wel' I should estimate, from my slight experience there, that living expenses are about three-fifths of what they are in the eastern United States. Most Englishmen in Jamaica do not realise or believe this, for they still cling to English food and English customs. Now the colony, a few years ago, attempted to secure the reduction of the salaries of colonial officials, and suggested a saving of 1000*l.* on the Governor's salary, but the proposition was promptly ended by that official's veto, which is absolute. So every attempt to decrease expenses by decreasing salaries has failed, and now retrenchment has to come somewhere, and since a zoologist is of small account, especially one who has some powerful enemies, Dr. Duerden is to be sent back to England. If this event actually takes place the blame will rest, not on Jamaica, but on England. There is little chance for the advance of scientific research in that island so long as it is looked on by English politicians as a possession to be exploited for the benefit of the office-holders.

I trust it is not yet too late for the scientific men of England to make such an emphatic protest to the proper authorities that the Board of Governors of the Jamaica Institute may be compelled to retain Dr. Duerden as curator of the museum, if he can be persuaded to stay, and if not, to secure some equally competent and well-trained investigator to fill his place.

HUBERT LYMAN CLARK.

Olivet College, Michigan, January 15.

The Mongoose in Jamaica.

IN Jordan and Kellogg's admirable little book, "Animal Life," we read (p. 293):—"The mongoose, a weasel-like creature, was introduced from India into Jamaica to kill rats and mice. It killed also the lizards, and thus produced a plague of fleas, an insect which the lizards kept in check."

As it is evident from this and other signs that the Jamaica mongoose is to become celebrated in text-books, it seems worth while to call attention to the facts actually known about it. An excellent summary showing the status of affairs in 1896 was written by Dr. J. E. Duerden and published in the *Journal* of the Institute of Jamaica, vol. ii. pp. 288-291. In the same volume, p. 471, are further notes on the same subject.

The creatures which increased and became a pest were ticks, not fleas. The present writer can testify to their excessive abundance in the island in 1892 and 1893. The species were various, and were examined by Marx and Neumann, whose determinations appear in *Journ. Inst. Jamaica*, vol. i. p. 380, and vol ii. p. 470. It will be noted that the common species are not confined to Jamaica, and, in fact, have probably, most of them, been introduced from elsewhere. Hence it is quite possible that their abundance is in large part due to their recent introduction.

T. D. A. COCKERELL.

East Las Vegas, New Mexico, U.S.A., January 17.

Thermochemical Relations.

LET us consider gr. 2 of H, gr. 16 of O and gr. 71 of Cl, namely, volumes 2 of H, 1 of O, 2 of Cl. We can combine these corps two by two to form the three following compounds:—

gr. 87 of Cl_2O gr. 18 of H_2O gr. 73 of HCl

that occupy respectively 2, 2, 4 volumes.

The heats of combination are respectively:—

$$-14 \qquad +58 \qquad +44,$$

between which is the simple relation

$$-14 + 58 = 44.$$

In another example, where one of the components is solid but remains the same ratio between the volumes of the compounds, we have again the same relation between the combining heats. In fact, with

gr. 2 of C gr. 4 of H gr. 32 of O

we can form

gr. 16 of CH_4 gr. 44 of CO_2 gr. 36 of H_2O

which occupy respectively 2, 2 and 4 volumes.

The combining heats are respectively

$$+19 \qquad +97 \qquad +116,$$

and we find

$$19 + 97 = 116.$$

Is it a casual coincidence or a law?

Spezia (Italy), Nov. 14, 1900. CARLO DEL LUNGO.

Direction of Spirals in Horns.

ABOUT Mr. Blanford's interesting remarks on my letter in NATURE for January 10, I should like to answer that, far from thinking the matter "simple," I find that the facts are nowhere recorded and certainly are not generally known to naturalists or sportsmen. This is why I attempted to formulate rules.

The rule that in antelopes the direction of the spiral is "crossed" (*i.e.*, the right horn is sinistral, and the left horn is dextrorsal) holds good in the Koodoos, Elands, Indian antelope, Bushbuck, Impalla, and Speke's antelope (noted by me in the *Lancet*, January 1, 1898, "On Spiral Growth").

In oxen the horns are "homonymous" in direction—the right horn twists to the right, the left horn to the left—and many horns show a good spiral. I may mention the Cape buffalo, musk ox, domestic ox, also the Urus and the Chartley bull. The only exception to the rule in the Cambridge Museum is an Indian buffalo.

In the sheep, the direction of the spiral is "homonymous," as in the ox, except *Ovis orientalis* and *Ovis nahura*.

In the goats, Mr. Blanford, in his "Fauna of British India, Mammalia," notes that there is a difference between the wild and the tame goats in the following passage: "But the spiral in tame goats is almost always in the reverse direction to that found in Markhor, the anterior ridge in the tame animals turning inwards at first in each horn.

"I have, however, seen exceptions; there is one from Nepal in the British Museum."

After searching many books on horns (including Mr. Lyddeker's), this is the only note on the direction of spirals that I can discover. The causes of the spirals, and of the differences in directions, are still to seek.

Cambridge. GEORGE WHERRY.

SOME DISPUTED POINTS IN ZOOLOGICAL NOMENCLATURE.

AMONG that large section of the general public who are interested, to a greater or less degree, in natural history there is a widely spread impression that, as most of the more familiar animals have a single, definite and indisputable popular designation, so every known species in the animal kingdom has one proper technical title by which it is known throughout the zoological world; and consequently that when they have once made themselves acquainted with this title, there is no more to be said on the subject. To a certain limited extent (some authorities would, perhaps, be inclined to say invariably) there is no doubt that this idea is perfectly well founded. But, in the first place, there is a difference of opinion among zoologists as to the limits of genera, and whereas one worker would retain a species in the genus in which it was placed by its original describer, another would regard it as entitled to represent a genus by itself. Thus one great element of diversity in nomenclature is introduced.

But there are also a very large number of cases in which an equal diversity of view obtains as to the proper specific title of an animal. And the inquirer will not be long in ascertaining that, in place of unanimity, an almost chaotic state of uncertainty prevails as to what should be the proper binomial designation of a large percentage of animals. Consequently, in place of being one of the easiest, the question of nomenclature is, in many cases, one of the most difficult; and the unhappy inquirer will too often find that he receives a different answer from almost every authority to whom he applies. Nor is this all, for whereas a considerable number of systematic zoologists are agreed in some measure upon certain general principles of nomenclature, their opinions are not shared by many of the workers in palæontology, morphology and geographical distribution, who adhere to more antiquated views on these questions.

The reasons for this regrettable and unfortunate state of affairs are many and varied. And as a crisis on the question is likely to arise in the near future, if indeed it be not already upon us, the editor is of opinion that there are many readers of NATURE who would like to be informed of some of the chief points at issue, and of the more important suggestions which have been made towards arriving at a settlement. It will consequently be understood that the present article has been written solely from this point of view, and that it makes no pretence to discuss all the questions, or to enter into details interesting to zoologists alone.

One of the points at issue—and it is one of the most important—is what we may term the theory of the sacredness and immutability of the specific name. Soon after Linnæus had completed the last edition of the "Systema Naturæ" published under his own personal supervision, it became apparent that a large number of the animals named by him could no longer be permitted to remain in the genera in which they were included in that work. The giraffe, for example, which had been named *Cervus camelopardalis* by the Swedish naturalist, was certainly entitled to generic distinction from the deer. At this date the idea of the "sacredness" of the species name had not yet originated, and Gmelin, in his edition of the

"Systema Naturæ," considered himself justified in "promoting" the specific title *camelopardalis* to generic rank, and proposing a new specific name for the animal thus designated. *Cervus camelopardalis*, Linn., thus became *Camelopardalis giraffa*, Gmelin. Similarly, in much later years, Gray changed the *Antilope strepsiceros* of Pallas into *Strepsiceros kudu*. According, however, to the modern school of zoologists, such changes were totally unjustifiable; and they hence advocate what is known as the "*Scomber scomber*" principle, on which the title of the kudu becomes *Strepsiceros strepsiceros*. To many (among them the secretary of the Zoological Society) such tautological titles are most repugnant; and in the case of the animal last mentioned they accordingly prefer to retain the title proposed by Gray. In the case of the giraffe, by a fortunate circumstance, the difficulty does not arise, for the generic title *Giraffa* had been proposed at an earlier date than the "promotion" of *Camelopardalis*, and the name of the animal consequently became automatically *Giraffa camelopardalis*. If the "sacredness" of the species name be insisted upon, and the tautology objected to, a way out of the difficulty in the case of the kudu and many other analogous instances might be found by making a new generic title, when the animal might be called *Kudua strepsiceros*. But the case of the striped hyæna, the *Canis hyaena* of Linnæus, then arises as an example of another difficulty. For this animal was subsequently named *Hyaena striata*, altered by the modern school to *Hyaena hyaena*; and if we refuse to accept the latter and yet desire to retain the original species name, we have to abrogate such a familiar generic title as *Hyaena*, and likewise the family name *Hyaenidae* (for there are but few who would advocate the retention of a family name when the generic title from which it is derived is abolished). The older naturalists, in the absence of any law to the contrary, considered themselves perfectly justified in promoting the specific title to generic rank, and personally we fail to see on what grounds the present generation think themselves entitled to override this decision, as, in our own opinion, there is no right or wrong in the matter. That similar changes are now forbidden is, of course, fully understood.

But bad, in the opinion of many, as is the tautology of *Strepsiceros strepsiceros*, worse is to follow. By those who admit the principle of "trinomialism" to designate local races of animals, if the kudu were divisible into two or more such races the typical form would, according to American writers, become *Strepsiceros strepsiceros strepsiceros*. And, again, if the lesser kudu were subgenerically separated from the larger species, the title of the typical race of the latter would become *Strepsiceros (Strepsiceros) strepsiceros strepsiceros!* We do not like to use the term absurdity in connection with the views of others, but it becomes almost difficult to refrain.

That some designation is advisable for local races of species is admitted by nearly all, but there is still a reluctance among many to accept the aforesaid trinomialism. To many such the interpolation of the word "var." between the specific and the racial title appears preferable; and to this plan there can be no objection, albeit it is somewhat more cumbersome. It must, however, be borne in mind that when the word "var." is inserted the third title must agree in gender with the species name, whereas in trinomialism proper it agrees with the genus name. To avoid tautology, many zoologists use the designation "typicus" for the type race of a species, but this usage is objected to by others in that it is practically a new subspecific title.

This, again, leads us to notice a modern change in regard to subgeneric titles. Formerly, when a genus was divided into subgenera, a new subgeneric name was proposed for the typical group, *e.g. Cervus* (*Eucervus*) *elaphus* for the red deer. Now, however, the practice is to repeat the generic name, as instanced above in the case of the kudu. In this connection it may be noticed that even those who object to the "*Scomber scomber*" principle come perilously near to it when subgeneric terms are employed, as in *Cervus* (*Dama*) *dama* for the fallow deer, which they would call *Dama vulgaris* if regarded as a separate genus. It should likewise be mentioned that the bracketing of a name is only admissible when it is used in a subgeneric sense, as above. Consequently the practice of indicating a synonym in this manner, *e.g. Microtus* (*Arvicola*), is totally unjustifiable, although it is frequently practised by biologists other than systematists.

The mention of *Microtus*, the title now employed by the modern school to designate the voles in place of *Arvicola*, which was in almost universal use a few years ago, brings us to the vexed question of priority. Although there are still many zoologists who adhere to the practice of using names (both generic and specific) which, in spite of not being the earliest, have been current in literature for a long period, the general trend of opinion is all in favour of the enforcement of the rule of priority (even to the bitter end) among systematists. In the main, it must be confessed that the advocates of this have reason on their side, as otherwise we are landed in almost hopeless difficulties. But admitting the general principle to be the most logical, may there not be room for the exercise of some discretion and common sense? A naturalist, for instance, years ago described, from a cave in America, what appears to be an upper premolar tooth of the white-tailed deer, to which he gave the name *Odocoileus*, on the supposition that it represented an unknown type of animal. As a matter of fact, he ought to have referred it to the genus *Cervus*, as that genus was then understood. Yet American naturalists propose to adopt this name for the white-tailed deer and its allies. Such usage is a premium on incompetence and ignorance; and it does not seem fair that names so given should supersede those proposed by workers who know their business. Of course there are many difficulties when the discretionary element is once introduced, but, like all others, they are not insuperable when properly handled.

One of the greatest evils arising from the wholesale change of names that has been introduced of late years through this revival of the right of priority is that it renders obsolete to a great extent works such as Dr. Wallace's "Geographical Distribution of Animals"—works that ought to stand for all time. It further involves the task of recollecting a double series of names if such works are not to be cast aside *in toto*. It is largely on this ground that so many biologists other than systematists refuse to conform to the new view. The evil induced by the change is undoubtedly great and much to be deplored; but it will certainly not be remedied by the refusal of one section of workers to follow in the footsteps of those of their brethren who alone have full opportunities of arriving at the best decision with regard to a matter bristling with difficulties.

From priority in nomenclature the transition to the question of preoccupation is an easy one. That the use of a generic name in botany is no bar to its employment is now generally conceded; but it is considered advisable that such names should be given as seldom as possible. Most zoologists are likewise agreed that when absolutely the same name has been once employed as the generic designation of any group of animals (whether it be in use or not), it cannot be employed for another. There is, however, a want of unanimity as to whether the same name with a different termination—*e.g. Hydropotes* and *Hydropota*, or *Mastodon* and *Mastodus*—may be used for two groups. Closely connected with this is the question whether the transliteration or grammatical formation of names should be amended—*e.g. Machairodus* to *Machaerodus*, or *Megatherium* to *Megalotherium*; and

whether, if they are not so amended, the use of both is admissible for different groups. Some even go so far as to say that an obvious error in the spelling of a name, as, for example, *Rhinchosaurus* in place of *Rhynchosaurus*, should not be amended, and that the previous use of the incorrectly spelt name should be no bar to its subsequent employment for another group in the correct form. To many, at least, of those who have even the slightest knowledge of the classics such a practice must be repugnant. And to a certain extent, at any rate, the same remark will apply to hybrid names, although the general consensus of opinion is now against the amendment of these. Less objection can be taken to meaningless names, or anagrams (such as *Xotodon*, the anagram of *Toxodon*), which, if euphoniously formed, serve their purpose fairly well. And the old objection against so-called barbarous names has of late years been waived by many workers. Although it is by no means a general view, such names are more euphonious when Latinised, as *Linsanga* in place of *Linsang*, and *Coendua* for *Coendou*. Then again there are names like *Camelopardalis* (giraffe), *Hippotigris* (zebra), and *Hippocamelus* (a deer), given on the supposition that the animals to which they refer are intermediate between the two indicated by the compound title. The two former have late classical authority, and may further be justified on account of the coloration of the animals to which they refer, but to some persons, at least, the acceptation of the third is objectionable. It must be confessed, however, that when once individual fancy is allowed play in matters of this sort, it is difficult to know where to draw the line.

Another class of names are those which have been given to species on the evidence of maimed specimens, or examples whose place of locality was incorrectly recorded. The great bird-of-paradise was thus named *apoda*, while the name *ecaudatus* has similarly been applied to at least one mammal. Again, a bear inhabiting the Himalaya has been named *tibetanus*, while there are even more flagrant instances of misapplied geographical titles. Many workers of the modern school assert that no errors of this kind should be amended; while some would even say that although Tibet is the accepted modern way of spelling the country of the lamas, yet that if the specific title was originally spelt *thibetanus*, so it must remain for all time. A common-sense, rather than a pedantic, view can, we think, be the only safe guide in such cases. When a name inculcates an error in geographical distribution, its retention, from this point of view, is clearly indefensible. So, again, in the case of names due to misconception or maimed specimens. Where, for instance, the name *ecaudatus* denotes a long-tailed animal, its retention is against common sense. On the other hand, where the feet of a bird are inconspicuous, as in the swift, no great exception can be taken to the use of the name *apus*.

The last point in dispute to which we have space to refer is the right of an author to withdraw a name proposed by himself in favour of some later title. A well-known instance of this is afforded by the name *Daubentonia*, proposed by Geoffroy in 1795 for the aye-aye, but, on account of preoccupation in botany, subsequently withdrawn by him in favour of Cuvier's name *Chiromys* (or *Cheiromys*, as it was originally spelt). Whereas the right of withdrawal was denied by Gray (and the older name revived), by Sir William Flower it was admitted. The modern tendency is to follow Gray. If the preoccupation of a zoological name by a botanical were now admitted, of course Geoffroy's change would be followed. The question is whether, being right according to the views of his own time, there is sufficient justification for saying that he acted *ultra vires*. Moreover, the possibility is to be borne in mind that the next generation of zoologists will revert to the view that the use of a generic term in botany bars its subsequent employment in the sister science.

To arrive at a settlement in regard to these and many other points in dispute will require forbearance and the subordination of individual inclinations to the voice of the majority; compromise and common sense being, we venture to think, at least as necessary as adherence to inelastic rules.

In the foregoing we have purposely refrained from making any reference to Mr. H. M. Bernard's proposal to abolish specific names in those forms of life "which cannot be at once arranged in a natural system," for the reason that, if we understand him aright, it is his intention that the abolition in question should apply only (for the present, at any rate) to corals, sponges, and perhaps other low types of invertebrates. Whatever, therefore, may be its merits or demerits, the proposal is not yet intended to apply to such forms of life as are capable of being arranged in some approximation to a "natural system"; and the discussion of the disputable points in connection with specific names alluded to above is accordingly not yet rendered superfluous.

R. L.

CHARLES HERMITE.

AMONG those mathematicians who assisted in making the nineteenth century, and more especially the Victorian era, a period of unparalleled activity in the scientific world, the name of Charles Hermite will be indelibly imprinted in our annals as that of one who did much to develop the study of higher algebra, geometry, analysis and theory of functions.

Charles Hermite was born at Paris in 1822, and at the age of twenty he entered the École Polytechnique. His mathematical genius was not long in showing itself, for shortly afterwards we find him corresponding, at the instigation of Liouville, with Jacobi on the subject of Abelian functions, and the predictions of the latter mathematician that Hermite would soon extend the fields of study which he himself had done so much to open out was soon verified. From the theory of continuous functions Hermite soon passed on to the theory of forms, and gave a general solution of the problem of arithmetical equivalence of quadratic forms. He also discovered a new arithmetical demonstration of Sturm's and Cauchy's theorems on the separation of roots of algebraic equations.

The study of higher algebra, which sprang into existence with the discovery of invariants, was opened up simultaneously by Cayley, Sylvester and Hermite, and it would appear that to the latter mathematician we are indebted for the law of reciprocity, the discovery of associated covariants and gauche invariants, and the formation of the complete system of covariants of cubic and biquadratic forms and invariants of the quintic. Concurrently with these researches in arithmetic and algebra, Hermite was engaged on the study of the transformation of hyperelliptic functions and expansions of elliptic functions, and he was also the first to show that the number of non-equivalent classes of quadratic forms having integral coefficients and a given discriminant is finite. In 1856 Hermite was elected to the Institut, being then thirty-four years of age. In 1858 he took an important step in connection with the study of elliptic and theta functions by introducing a new variable connected with the q of Jacobi by the relation $q = e^{i\pi\omega}$, so that $\omega = ik'/k$. He was then led to consider the three modular functions denoted by $\phi(\omega)$, $\chi(\omega)$ and $\psi(\omega)$.

A transcendental solution of the quintic involving elliptic integrals was given by Hermite, the first paper appearing in the *Comptes rendus* for 1858 and subsequent papers in 1865 and 1866. After Hermite's first publication, Kronecker, in a letter to Hermite, gave a second solution, in which was obtained a simple resolvent of the sixth degree.

We are also indebted to Hermite for the first proof that e, the base of the Napierian logarithms, is transcendental, a result which paved the way for Lindemann's proof that the same is true of π.

In 1862 Hermite was elected to a newly founded chair at the École Normale, and later on he also became professor at the École Polytechnique and the Sorbonne. Instead of continuing to teach on the old lines which he found still in vogue, Hermite introduced into his lectures the great discoveries of Gauss, Abel, Jacobi and Cauchy. He thus founded for France a new school of higher geometry, and the large number of mathematicians of distinction who have studied under him bear abundant testimony to the success of his innovation.

During the later period of his life Hermite appears to have directed his attention more especially to questions connected with the calculus. In conjunction with Darboux and Jordan, he presented the general theory of linear differential equations in an entirely new light, choosing the algebraic rather than the geometric method of presentation. His work on Lamé's equation leads to the solution of a large number of problems in applied mathematics.

The "Cours de M. Hermite" constitutes an important work on the theory of functions.

About eleven years ago Hermite delivered an inaugural address before the President of the French Republic, which was published in the *Bulletin des Sciences mathématiques* for January 1890. In 1892 he celebrated his jubilee, and it is remarkable that the same year witnessed also the jubilee of Pasteur. The new century and the new era in history which has come upon our country will both be the poorer for the loss of M. Hermite, but his works will be handed down to posterity.

An account of his work has been given in the *Comptes rendus* for January 21 by M. C. Jordan, himself the author of important papers on the fields of study which Hermite had chosen to work in. To this account we are indebted for much matter contained in the present notice, and we are glad that M. Jordan pleads for the publication of Hermite's collected works. Many of his ideas are scattered in journals or letters that are difficult of access, and it will be of inestimable use to mathematicians to have them printed in book form.

G. H. B.

ADOLPHE CHATIN.

ADOLPHE CHATIN died on January 13 at the age of eighty-seven. He was a native of Dauphiné, and was born at Ile-Marianne-de-Saint-Quentin, near Tullins, "d'une famille peu fortunée," according to M. Gaston Bonnier, from whose éloge in the *Comptes rendus* of the Paris Academy (January 21) some of the following facts of his life-history are taken. He received his early education at Tullins, and at seventeen joined an apothecary at Saint-Marcellin. Three years later (1833) he went to Paris under an apothecary named Briant, who, recognising his pupil's capabilities, urged him to study pure science as well as pharmacy. Chatin, who always gratefully remembered his good friend's advice and encouragement, worked to such effect that he took bachelors degrees both in Letters and Science, and six years after his arrival in Paris obtained the degree of Doctor of Science. In the next year, 1840, he read his thesis before the School of Pharmacy, and was duly admitted. The somewhat ambitious title of this thesis, "The Comparative Anatomy of Plants applied to Classification," indicated the line of work in which he has done most service to botany. It was a short paper dealing with the occurrence, structure and general properties of albumen in plant-seeds. He took the view that the presence of endosperm in the seeds, implying a temporary arrest in the embryogeny of the plant, indicates a lower condition than that existing in the exalbuminous seed. "From this time," he tells us in the introduction to the "Anatomie Comparée des Vegetaux," "comparative anatomy was (with plant symmetry) the principal object of my labours."

In 1844 he took the degree of Doctor of Medicine, and in 1848 was elected to the chair of Botany at the School of Pharmacy, his chief competitor being M. Payer. Twenty-five years later he became Director of the School, retiring in 1886 with the title of Honorary Director. In 1874 he was chosen a member of the Academy of Science, succeeding Claude Gay, and in 1897 became President of the Academy. He was also a member of the Academy of Medicine, and filled various other posts of honour.

His first memoir, published in 1837, was on the symmetry of structure of plant organs, and sixty years later appeared the last part of his studies on the symmetry of the vascular bundles of the petiole. His best-known work is the "Anatomie Comparée" (1856-1862), which was never completed. It consists of two parts, the larger illustrated by 113 plates, on Dicotyledonous Parasites, the smaller with 20 plates, on Aquatic Monocotyledons. It is difficult to estimate the value of this work. Its chief worth lies in the beautifully executed figures illustrating the anatomy of the stem, leaf and root of a large number of genera and species. Their preparation implies considerable skill and much hard, conscientious labour, with which the results, as embodied in the text of the book, are scarcely commensurate. But it is hard to judge the work of forty years ago from our present standpoint, and in helping to revive the study of plant-anatomy, which had fallen into neglect, Chatin did good service, and might well, in his later years, regard with some complaisance and pride its present important position as one of the factors in the evolution of a natural system of plant-classification.

Chatin also studied the organogeny of the flower, especially of the andrœcium, and collected the results of numerous small papers, which had previously appeared in the *Comptes rendus* and elsewhere, in a volume entitled "De l'Anthère" (1870)—a comparative account of the development, structure and mode of dehiscence of the anther in a number of families and genera. His memoir on the life-history and structure of *Vallisneria spiralis* is a useful piece of work, illustrated with characteristic elaborate detail. But he by no means restricted himself to the study of the symmetry and anatomy of plants; the subjects of his published works and papers comprise the results of chemical as well as botanical investigations. Among his earlier papers were several dealing with the occurrence of iodine in air and water, its presence in plant tissues and its effect on plant growth. He also wrote on the potato disease, the vine disease, and on the cultivation of truffles and other edible fungi, and published a small book on watercress.

For the past two years his health, hitherto robust, had been gradually failing, and his last days were spent in retirement at his country home at Essarts-le-Roi, near Rambouillet. His son, M. Joannes Chatin, a professor at the Sorbonne and a member of the Academy, has made a few contributions to botanical literature, but his work has been chiefly in other branches of science.

NOTES.

ARRANGEMENTS are being made by the Royal Academy of Sciences of Sweden to celebrate the third centenary of the death of Tycho Brahe, the founder of modern practical astronomy, on October 24, 1901, by a special meeting. It is also proposed to further commemorate Tycho's work by the publication of a facsimile of the original edition of his celebrated "Astronomiæ instauratæ mechanica," a perfect copy of which is in the library of the Academy. It is well-known that when at Wandesburg

in the year 1598, Tycho had this work printed in his own office, with the view to give the celebrities of his time an exact idea of the organisation of the observatory which he had left for ever. But the edition appears to have been small, for the only copies of the work now known to be in existence are two at Copenhagen, and one each at the British Museum, Prague, and Stockholm. Another edition was printed four years later at Nuremberg, but it is not nearly so fine as that printed by Philip de Ohr at Wandesburg. Subscriptions are invited for the facsimile of the Stockholm copy of the work, and should be sent to Prof. Hasselberg, Royal Academy of Sciences, Stockholm, Sweden, before March 1. The price is fixed at 2*l.* a copy.

THE gold medal of the Royal Astronomical Society has been awarded this year to Prof. Edward C. Pickering, of Harvard College Observatory. The medal will be presented at the annual general meeting of the Society, which will be held at 3 p.m. to-morrow (Friday).

ON January 28 Scottish geology lost a most successful and enthusiastic fossil-collector in Mr. James Bennie, who then passed away at the ripe age of seventy-eight years. He began, while an artizan, in early life to employ his leisure hours in gathering fossils from the Carboniferous formations around Glasgow and from the Glacial deposits of the West of Scotland. So successful were these excursions and so excellent his published descriptions of the results obtained from them that in the spring of 1869 he was invited to join the Geological Survey of Scotland as Fossil Collector. He was thenceforth able to devote his whole time to work which had previously been only possible for him in his scanty hours of leisure. His career in the Survey was marked by remarkable industry, insight and success. He acquired a more minute knowledge of the palæontological stratigraphy of the Carboniferous system than was probably possessed by any one else. He discovered the first recognisable traces of *Holothuria* in that system, and obtained remains of scorpions from many different horizons. To his acute faculty of observation we owe the first recognition of the little Arctic *Apus* among the deposits of lakes of the Glacial Period in Scotland. He was not only a lynx-eyed collector but wrote well, and supplied many interesting papers to the *Transactions* of the Geological Societies of Edinburgh and Glasgow. He was fond of English literature, and when too poor to purchase Tennyson's Poems, borrowed a copy and transcribed it all. The value of his work was recognised two years ago by the Geological Society of London, which awarded him the Murchison Fund. His gentle and kindly nature, his cheery helpfulness and his loyal devotion to duty made him a great favourite with his colleagues, from whom he retired in 1897 on a well-merited pension.

AT University College, London, last week Prof. Schäfer was presented with a testimonial subscribed for by a number of those who had been his pupils or who had worked in the physiological laboratory during his tenure of office as Jodrell Professor of Physiology. From a report in the *British Medical Journal*, we learn that the chair was taken by Prof. Thane, who sketched the main features of Prof. Schäfer's connection with University College, and spoke of the esteem in which he was held alike by pupils and colleagues. The presentation was made by Dr. Leonard Hill, F.R.S., who, in a short and sympathetic speech, referred to the way in which Prof. Schäfer had stimulated physiological inquiry, and won, not only the respect, but the affection of those who were privileged to learn from him or to work under him. The presentation took the form of a bowl and two platters of hammered silver, designed and made by Mr. Alexander, of University College School, and of a cheque for a sum of money which is to be devoted to founding a medal to be given for the encouragement of physiological research in University College. Prof. Schäfer, who was very warmly received, said that the occasion recalled to him another occasion in the same theatre some thirty years ago. He then learnt from the lips of Sharpey that he had won the medal in physiology, and received it from the hands of Huxley. He believed that that circumstance had determined him to follow physiology as a career.

DR. R. A. DALY, of the Department of Geology and Geography of Harvard University, is endeavouring to organise a geological and geographical excursion in the North Atlantic for the summer of 1901. Conditionally on the formation of a sufficiently large party, a steamer of about 1000 tons, specially adapted for ice navigation, and capable of accommodating sixty persons, will leave Boston on or about June 26 and return to the same point on or about September 20. The main object of the voyage will be to offer to the members of the excursion party opportunity of studying the volcanic cones and lava-fields, the geysers, ice-caves and glaciers of Iceland, the fiords and glaciers of the west coast of Greenland, and the mountains and fiords of Northern Labrador. Some attention will be paid to the hydrographic conditions of the waters traversed. Botanists, zoologists, ornithologists, mineralogists and persons interested in other branches of natural history may pursue independent studies. A hunting party may take part in the expedition; it could be landed for a fortnight or three weeks in Greenland and for about the same period in Labrador. Explanatory lectures on the regions visited will be given from time to time by the leader of the excursion, Dr. Daly, who will also act as guide on the Labrador coast, where he spent the summer of 1900. An inclusive fee of 500 dollars for each member will be charged, 250 dollars to be deposited with the leader of the expedition on or before March 15. Applications for membership should be addressed to Dr. R. A. Daly, Harvard University, Cambridge, Mass., U.S.A.

WE regret to have received information of the death of the Nestor of European botanists, Dr. J. G. Agardh, of Lund, who died on January 17 in his eighty-eighth year. Prof. Agardh was chiefly known for his work in marine algæ. He was a correspondant of the Section of Botany of the Paris Academy of Sciences.

A NATURAL History Section has been formed of the Hampstead Astronomical and Scientific Society, with the primary object of working out the local fauna and flora. Meetings of the section will be held from time to time, when exhibits will be made, papers read, and discussion on zoological and kindred subjects invited. The honorary secretary for the section is Mr. J. W. Williams, 128, Mansfield Road, Gospel Oak, N.W.

MR. WILLIAM H. CROCKER, of San Francisco, has offered to defray the expenses of a solar eclipse expedition to be sent by the University of California from the Lick Observatory to Sumatra to observe the total eclipse of the sun on May 17. An astronomer and assistants will sail from San Francisco on February 19, to be absent until July. It is proposed to establish an observatory camp somewhere within twenty miles of Padang, on the west coast of Sumatra.

THE "Historical Number" of the *Electrical Review* of America (January 12) is full of notes and articles of interest to students of electricity. The number contains several very readable and informing papers on various branches of electrical work, and a series of portraits of men who contributed to the progress of electrical science and industry during the past century.

WE learn from *Science* that Mr. J. W. Sprague, who died recently, left a will that should ultimately greatly benefit the Smithsonian Institution. It gives 85 per cent. of the interest on

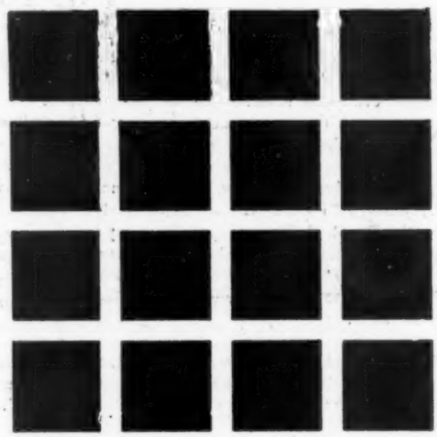
the estate to relatives for life. On their death the entire property, increased by 15 per cent. of the income to be laid by each year, is held in trust for twenty years, and then reverts to the Smithsonian Institution. One-half of the annual income is then to be added to the principal each year, and the other half is to be used for the advancement of the physical sciences by prizes, lectures or original research. It is estimated that the fund now is worth 200,000 dollars, and that it will be available in about fifty years.

DR. NORMAN MOORE will deliver the Harveian Oration of the Royal College of Physicians of London on St. Luke's Day, October 18, and Dr. Judson S. Bury, of Manchester, the Bradshaw Lecture in November. Dr. W. H. Corfield has been appointed the Milroy Lecturer for 1902. A subscription of fifteen guineas has been voted by the College to the fund for erecting a statue of Dr. William Gilbert, a former president, in the new Town Hall of Colchester. The adjudicators of the Weber-Parkes Prize for 1900 have reported that they have been unable to find any original work, published since the last award, which in their judgment would satisfy the conditions of the trust. Dr. J. F. J. Sykes will deliver the Milroy Lectures on February 28 and on March 5 and 7, on "The Influence of the Dwelling upon Health"; Dr. H. Head, F.R.S., the Goulstonian Lectures on March 12, 14 and 19, on "Certain Mental States associated with Visceral Diseases in the Sane"; and Dr. J. Frank Payne the Lumleian Lectures on March 21, 26 and 28, on "Cancer, especially of the Internal Organs."

FREE railway transport is granted to members of the staff of the New Mexico Agricultural Station engaged in experimental work and investigation, by the principal railway companies of the territory. This, remarks Dr. F. W. Sanders in a report just to hand, will enable the station to serve the public interests more perfectly than it has been possible to do in the past. Mr. A. Goss concludes, from results obtained during three years, that a number of districts in New Mexico can produce remarkably good beets, both as to sugar content and purity. Prof. T. D. A. Cockerell, the Station entomologist, who has for a number of years interested himself in the pigments of insects and plants, refers to a red colouring matter of the roots of the small borraginaceous plant *Eremocarya micrantha*, which may prove of service the properties of the pigment. The pigment belongs to the anthocyan series, and behaves exactly like litmus, turning red in the presence of acids, blue in the presence of alkalies. It is superficial on the roots, and readily soluble in cold alcohol. This pigment is thus an excellent native substitute for litmus, and might possess commercial value. Not only is it purer than commercial litmus, but its preparation is very much simpler, and the roots are easily obtained. The matter is now being further investigated by the Division of Botany of the U.S. Department of Agriculture, and we shall doubtless be informed of the results before very long.

WE have received from Dr. Hergesell, President of the International Aëronautical Committee, an account of some preliminary results of the balloon ascents made on January 10. There were 15 ascents, including both manned and unmanned balloons; of these three started from Vienna, four from Berlin, and four from Strassburg. Altitudes varying from 4500 to 12,000 metres were attained by the unmanned balloons and some very low temperatures were registered. Three of the manned balloons ascended above 3000 metres. Several inversions of temperature with height were recorded—*e.g.* Vienna, 23°·7 at 500 metres, 34°·2 at 1000 metres, 32°·4 at 2000 metres; at Berlin, 25°·5 at starting, 32°·0 at 790 metres, 41°·0 at 1460 metres, 32°·4 at 2825 metres, while at 6670 metres the temperature had fallen to −22°·0. Ascents were also made at London and Bath, but the results are not given in Prof. Hergesell's summary. One of the balloons from Berlin, with Messrs. Berson and Hildebrandt, descended in Sweden after a flight of nearly fourteen hours.

A CURIOUS optical illusion is produced by the accompanying figure from *La Nature*. At the places where the white strips separating the black squares cross one another, a hazy penumbra can be seen. If, however, attention is concentrated upon one



of these spots it disappears, though the others remain visible. It would be interesting to vary the dimensions of the squares and intervening white spaces, and thus determine when the effect ceases to be seen.

THE thermal death-point of the tubercle bacillus is the subject of an important paper by Messrs. Russell and Hastings in the "Seventeenth Report of Wisconsin Agricultural Experimental Station." The general results obtained entirely confirm the experiments of Prof. Theobald Smith (see NATURE, vol. lxiii. pp. 166 and 205), and are as follows:—"(1) Exposure of tuberculous milk in a tightly closed commercial pasteuriser for a period of ten minutes destroyed in every case the tubercle bacillus, as determined by inoculation experiments (*i.e.* at a temperature not exceeding 68° C.). (2) When milk is exposed under conditions which would enable a pellicle to form on the surface, the tubercle bacillus may resist the action of heat at 60° C. for considerable periods. (3) In order to thoroughly pasteurise milk without injuring its creaming properties or consistency, it should be heated in closed pasteurisers for a period of not less than twenty minutes at 60° C. Under these conditions, it is certain that disease bacteria such as the tubercle bacillus will be destroyed without the milk or cream being injured in any way."

There has been considerable diversity of opinion concerning the ethnic affinities of the Slavs, and Zaborowski returns to the subject in a recent number of the *Bulletins et Mémoires de la Société d'Anthropologie* (5), I., 1900. His view is that the Slavs belong to the same race as the Celts of French anthropologists, that is, being brunet brachycephals, they are members of the Alpine race. Their original home was that which is still occupied by the southern Slavs between the Danube and the Adriatic, and they were allied to the inhabitants of the Terramara of Emilia. The northern Slavs migrated along the valley of the Vistula and reached the shores of the Baltic, where they developed a civilisation and introduced in this region the practice of burning their dead, which was previously unknown there; they also brought with them metals and glass.

Wherever the Slavs migrated they introduced the custom of incineration, and carried with them the characteristic metal head-rings, the ends of which terminated in sigmoid curves (Hackenringe). The settlement of the Venede on the Baltic dates back to the fourth century, B.C. The Baltic Slavs were profoundly affected by the expansion of the Germans about the beginning of our era, but apparently not till the eighth century A.D., did the slavs colonise Northern Russia.

MR. R. SHELFORD, of the Sarawak Museum, has sent us a copy of his paper in the October number of the *Ibis*, describing the arrangement of the down and plumage in the embryos and young of *Centropus sinensis*—an aberrant cuckoo. Certain differences from the arrangement obtaining in the allied *C. celebensis* are noticed.

THE sixth fasciculus of vol. v. of the Memoirs of the Boston (U.S.) Society of Natural History is devoted to an elaborate memoir by Mr. R. P. Bigelow on the anatomy and development of the medusa known as *Cassiopea xamachana*. In common with the allied *Polyclonia frondosa*, this is a form specially modified for a sedentary existence in shallow water among mangrove roots.

WE have received the Report of the Museums Association for 1900, containing the account of the meeting held at Canterbury in July last under the presidency of Dr. Henry Woodward. It is satisfactory to learn that this useful association is in such a flourishing condition that it has to consider how best to spend its surplus income. The Report includes the President's address, together with twelve papers and various notes. Mr. F. A. Bather gives specimens of descriptive museum labels for certain groups of echinoderms, but the extreme technicality of these suggests that they are suited for a zoological text-book rather than for the ordinary public. A heading like "CRYPTOBLASTUS, E. AND C," is calculated to mystify rather than enlighten the uninitiated. In his address, the President dwells on the difficulty of amalgamating the recent and fossil zoological collections in the British Museum owing to the constitution of the Staff.

THE abstract of a paper by Dr. W. H. Gaskell on the origin of the eyes of vertebrates and the meaning of the second pair of cranial nerves appears in the November issue of the *Proceedings* of the Anatomical Society. After stating that the ancestor of the vertebrates possessed a pair of diverticula from the fore part of the alimentary canal with which the ganglia of the retina and the optic stalks of the lateral eyes were connected, the author pointed out that such a pair of blind diverticula exist in generalised crustaceans, such as *Branchipus* and *Apus*, adding that there is a connection between these diverticula and the retinal ganglion. It is therefore assumed that similar structures existed in the extinct trilobites. From this and other evidence it is inferred that the origin of the vertebrate eye is traceable to an animal derived from the trilobite stock, such as was abundant when the fish-like cephalaspids made their appearance.

THE horary values of the magnetic elements (declination and horizontal force) at Copenhagen, in the years 1895–1896, are given by M. Adam Paulsen in the *Annales* de l'Observatoire magnétique de Copenhague, just received from the Denmark Meteorological Institute, of which M. Paulsen is director.

THE Sanitary and Economic Association, Ltd., Gloucester, have sent us a pamphlet published by them for the purpose of promoting the economy of coal, the abatement of smoke, and the diffusion of an elementary knowledge of the first principles of warming and ventilating generally.

PROF. S. P. THOMPSON'S interesting story of "Michael Faraday: His Life and Work," published in the Century Science Series, is now available in the popular edition at the low price of half-a-crown. The book was reviewed in NATURE of June 8, 1899 (vol. lx. p. 123). Messrs. Cassell and Co. are the publishers.

MESSRS. SAMPSON LOW, MARSTON AND CO. have published the sixth edition of Mr. N. E. Yorke-Davies' little book on "Health and Condition in the Active and the Sedentary." The book contains a clear statement of the laws of health, with special reference to the dietetic treatment of ailments due to errors in eating and drinking.

ONE of the most remarkable catalytic agents recently discovered is metallic nickel, reduced from its oxide at a low temperature. Two or three years ago MM. Sabatier and Senderens showed that this metal is capable of causing the direct combination of hydrogen with ethylene and acetylene, ethane being formed in both cases. In the current number of the *Comptes rendus* they now show that reduced nickel is a very active catalytic agent, so far as the addition of hydrogen is concerned surpassing even spongy platinum. Thus a mixture of hydrogen and benzene vapour, passed over reduced nickel at about 200° C., readily gives hexahydrobenzene, no benzene escaping conversion if the hydrogen is in excess. The reaction appears to be a general one, since the homologues of benzene behave similarly; nitrobenzene is reduced to aniline.

THE phenomenon of birotation of the sugars has given rise to a considerable amount of work without any very definite results being obtained. In the current number of the *Zeitschrift fur physikalische Chemie* there is a paper, by Dr. Yukichi Osaka, on the birotation of *d*-glucose, which throws much light upon this subject, and forms an interesting application of the dissociation theory of solution. From the velocity constants of the change of rotation of *d*-glucose, both alone and in presence of acids, bases and neutral salts, it is shown that this sugar acts as a weak acid, the velocity of the change of rotation being proportional to the concentration of the hydroxyl ions, and to the square root of the concentration of the hydrogen ions.

THE additions to the Zoological Society's Gardens during the past week include a Sykes's Monkey (*Cercopithecus albigularis*) from East Africa, presented by Mr. J. Coombes; two Black-necked Swans (*Cygnus nigricollis*) from Antarctic America, a Yellow-rumped Parrakeet (*Platycercus flaveolus*) from Australia, three Blue-fronted Amazons (*Chrysotis aestiva*) from South America, deposited.

OUR ASTRONOMICAL COLUMN.

VARIATIONS IN THE MOTION OF THE TERRESTRIAL POLE.—In the *Astronomical Journal* (vol. xxi. No. 489), Prof. S. C. Chandler investigates the data available for determining the changes in the annual elliptical component of the polar motion. References to these changes have been previously made in *A. J.* Nos. 422 and 446, but no decisive conclusions could then be made. The data are taken from the records at Pulkowa, Leyden, Washington, Berlin, Cambridge and Madison, and are grouped for two epochs, 1865, 1883. From each series the effect of the 427-day term of the latitude variation is eliminated after correction to a uniform value of the aberration constant and stellar parallax; from the residuals the constants of the annual term of the latitude variation are found, and finally, by combining these constants for all the series at each epoch, the elements of the ellipse are computed for 1865 and 1883.

The present article considers all records prior to 1890, and the result indicates that the line of apsides is revolving from east to west, or in a direction contrary to that of the pole in its orbit, in a long period of some 75 years—*i.e.* at a rate of about 5° annually; also that the length of the annual period oscillates about its mean value, the fluctuations having a long periodical character, with a cycle of about 60 years.

DEFINITIVE ELEMENTS OF THE ORBIT OF COMET 1898 VII.—Nos. 3684, 3685 of the *Astronomische Nachrichten* are devoted to an exhaustive discussion, by Mr. C. J. Merfield, of Sydney, of the data recorded for the comet discovered by Mr. Coddington at the Lick Observatory on June 11, 1898. Some 400 observations are utilised, the largest series being those made by Mr. Tebbutt at Windsor, New South Wales.

Epoch of Osculation 1898 *June* 21.

$$T = 1898 \text{ Sept. } 14{\cdot}0442056 \text{ G.M.T.}$$

$$\left.\begin{array}{l} \omega = 233^\circ\ 15'\ 18''{\cdot}66 \\ \Omega = 74\ \ 0\ \ 58{\cdot}17 \\ i = 69\ \ 56\ \ 0{\cdot}37 \end{array}\right\} 1900{\cdot}0$$

$$\log q = 0{\cdot}2308587.$$
$$\log e = 0{\cdot}0004487.$$
$$e = 1{\cdot}0010336.$$

OBSERVATIONS OF EROS.—Several observers are now commencing to publish their lists of measures of the planet Eros, made during the recent opposition. In the *Astronomische Nachrichten* (Bd. 154, No. 3683), Prof. A. Abetti gives a long list of measures taken during July, August, September, October and December 1900 at Arcetri-Firenze.

M. J. Pidoux also contributes a series obtained during October and November 1900 at Geneva, and Signor A. Antoniazzi others during July and August 1900 at Padova.

PHOTOGRAPHIC CATALOGUE OF POLAR STARS.—The first issue of the *Publications of the Vassar College Observatory*, U.S.A., contains a catalogue of sixty-five stars within one degree of the North Pole, reduced by Miss C. E. Furness from photographs obtained with the 13-inch Helsingfors astrographic refractor. A discussion of the results in a manner suggested by Prof. Jacoby, of Columbia University, led the conclusion that, within the limits of the plates—2° square—no optical distortion was to be detected.

AUDIBILITY OF THE SOUND OF FIRING ON FEBRUARY 1.

ON Friday last, between three and four in the afternoon, the body of our lamented Queen was conveyed from Cowes to Portsmouth past a fleet consisting of some of the finest battleships of the world. The minute-guns fired from these vessels during the passage of the funeral procession were clearly heard at great distances from Spithead; for, from the regularity of the discharges, there can be little doubt as to the origin of the reports.

We have received several letters referring to the sounds heard at various places. Prof. E. B. Poulton, F.R.S., writes as follows from Youlbury, Boar's Hill, near Oxford:—

"During the interval between three and four o'clock on the afternoon of Friday, February 1, many people on this hill, about 520 feet above sea-level, including Mr. Arthur J. Evans and I, heard the sound of distant guns. The period over which the sounds were heard, the direction from which they appeared to come, the mode of their occurrence in groups separated by intervals of silence, led us to believe that they were the guns of the fleet ranged between Cowes and Portsmouth, and that each group of sounds represented the salute of a single ship as it was passed by the Royal Yacht. Judging from an old atlas the distance appears to be about sixty-seven miles in a straight line. The afternoon was bright and sunny and the air very still. The sounds could be distinctly heard in the house with closed windows. Out of doors they were really impressive. It is probable that other records will reach you, indicating that they were noticed at much greater distances."

Prof. F. J. Allen and Mr. C. Thwaites heard the reports very distinctly at Sutton, Surrey, which is about sixty miles from Portsmouth, and the latter states that the windows of a house were slightly shaken with each discharge.

Several letters from correspondents who heard the sounds have appeared in the *Times*, the *Standard* and the *Daily News*. Towards the east, the booming of the guns was distinctly heard at Beachy Head (60 miles from Spithead), near Brightling (69 miles) and Woodchurch (84 miles); towards the east-north-east, near Tunbridge Wells (66 miles); towards the north-east, at Wallington (59 miles), Croydon and Richmond Hill (62 miles), and Bexley (75 miles); towards the north-north-east, near King's Langley (74 miles); and towards the north, at Marcham (near Abingdon, 64 miles), Great Missenden (69 miles), Oxford (70 miles), Witney (73 miles), and Leighton Buzzard (84 miles). The concussion was sometimes strong enough to shake windows at Wallington, Richmond Hill and Great Missenden. Near Brightling, cock-pheasants crowed as they do during a thunderstorm. As a rule, there appears to have been little or no wind to interfere with the propagation of the sound-waves.

JUPITER AND HIS MARKINGS.

JUPITER is now visible as a morning star, and observers have resumed their investigations of his surface markings. The coming opposition on June 30 will not be a favourable one for telescopists in Europe, as the planet will be in about 23 degrees of south declination, and therefore at a very low altitude.

The lingering relics of the great red spot, situated within the hollow in the south side of the southern equatorial belt, will probably be a difficult feature in the circumstances. But it should be carefully looked for, and its times of transit across the central meridian of the planet noted as frequently as possible. These will occur during February, about 80 minutes after the times given for the zero meridian (System II.) by Mr. Crommelin in his ephemerides published in the *Monthly Notices* for December 1900. Whenever the red spot itself cannot be distinguished, it will be advisable to take the time of transit of the hollow in the belt, which is a very easy object. In recent years the rotation of the spot and hollow has exhibited a slow decrease of speed, amounting to about one-tenth of a second annually. In 1896 the period was 9h. 55m. 41·3s., in 1900 9h. 55m. 41·8s. On February 15, 1901, the longitude of the spot will be about 48°, if the retardation has continued. Its easterly drift will bring it into longitude 51°·5 on June 15, 1901, and 61°·5 on June 15, 1902.

With regard to the equatorial spots, these have shown a mean motion of about 9h. 50m. 24·1s. during the past three years, and this is about six seconds shorter than the period adopted for System I. in the ephemerides above referred to.

The study of Jupiter during the present year may have a special significance, for it is likely to throw an important light upon the question whether or not certain features on the disc are recurrent at pretty regular intervals. There is a belt in about 23° north latitude which displayed some remarkable outbreaks of spots in 1869, 1880 and 1890, and a similar phenomenon is now again due if such outbreaks are periodical and owe their origin to some disturbing action repeated on the planet at intervals of about a decade. The features alluded to move more rapidly than any other markings observed on the disc. The same, north temperate, belt is often marked with small dark spots or condensations, but these travel with normal velocity and differ little from the rate of the red spot. There is another current in this region conforming with a period of 9h. 56m., which is probably slower than any other Iovian current. In the southern hemisphere, south of the red spot, there are two well-pronounced streams translating their various markings along at rates of 9h. 55m. 19s. and 9h. 55m. 7s. for a complete circuit.

Among other details offered by the planet may be mentioned the colours of the belts and their relative intensity and distribution over the disc. The value of continuous observation of the forms and motions of the markings in various latitudes is very great. It is only by collecting a mass of results during many consecutive years that proper investigation can be made and the various changes in progress assigned their proper periods. Until quite recently observations were somewhat irregular and altogether insufficient for a complete discussion of the phenomena. During the coming opposition observers in the southern hemisphere will have the planet well placed, and ought to be able to supply any deficiencies in the results obtained at northern observatories.

W. F. DENNING.

AGRICULTURE IN THE WEST INDIES.

THE third annual Agricultural Conference, under the presidentship of Dr. Morris, Commissioner of the Imperial Department of Agriculture for the West Indies, was held in the Legislative Chamber, Bridgetown, Barbados, on January 5. Besides Dr. Morris, the president of the Conference, and some fifty official, scientific, agricultural and educational representatives from the various West Indian colonies, there were present the Acting Governor, a large number of officials and representatives of the Legislature, and visitors.

After the usual preliminary formalities, Dr. Morris delivered his presidential address, which afforded a clear summary of the progress made by the Department of Agriculture for the preceding year and enumerated the questions which this Conference would be invited to discuss. The work of the officers of the Department during the preceding year covered a wide range. In the domain of the sugar industry it comprised researches to improve the sugar cane, experiments to reduce the cost of cultivation, efforts to advance the erection of central factories and researches upon insect and fungoid diseases, including an exhaustive investigation and monograph by the entomologist, Mr. H. Maxwell Lefroy, on the moth borer (*Diatraea saccharalis*).

Besides the work of the Department on the cacao industry and the lime industry, an attempt had been made, with prospects of success, to establish the growing of early potatoes for the English market; a small but promising onion industry had been established in Antigua, and there was every reason to believe that the fruit trade between Jamaica and the United Kingdom would receive an enormous impetus by the subsidising a direct fruit steamer service between the Mother Country and that Colony.

Agricultural education had occupied a large share of attention; the teachers of the elementary schools of nearly all the colonies were being trained by courses of lectures and demonstrations to teach the elementary principles of agriculture in their schools; seven exhibitions, of value varying from 10*l.* to 75*l.* per annum, had been awarded to pupils from first grade (public) schools in the various islands which were tenable at Harrison College, where a two years' course in agricultural science was given by the Science Department, Barbados. Agricultural industrial schools had been opened at St. Vincent and Dominica.

Nine botanic stations were now supported by Imperial funds, and a large number of experimental stations had been instituted in the various colonies, where experiments were being systematically carried out on questions connected with the sugar cane and all the other products of the West Indies.

Agricultural shows had been successfully carried out in three of the islands under the auspices of the Department, which had contributed 350*l.* in prizes and more than one hundred diplomas of merit.

The address concluded with some remarks upon the subject of the treatment of diseased plants, and upon the advisability of legislation with a view to prevent the introduction of plant disease into colonies from without, and to provide for the eradication of disease within the colonies.

The following papers were read during the Conference:—

Sugar Industry: Recent experiments with seedlings and other canes, by Prof. d'Albuquerque and Mr. J. R. Bovell (Barbados), and a short history of seedling canes in Barbados, by Mr. J. R. Bovell (Barbados), followed by a discussion in which representatives from all the colonies took part; cane farming in Trinidad, by Prof. Carmody (Trinidad); insect pests of sugar cane, by Mr. H. Maxwell Lefroy, entomologist of the Department; fungoid diseases of the sugar cane, by Mr. Albert Howard (Barbados).

Educational: Agricultural education and its place in general education, by Rev. Canon Simms (Jamaica); teaching the principles of agriculture in elementary schools, by the Hon. T. Capper (Jamaica); results of ten years' experience with compulsory enactments in the Leeward Islands, by Mr. C. M. Martin (Leeward Islands).

General:—Legislation to control bush fires, by Dr. H. Nicholls (Dominica); the treatment of soils in orchard cultivation in the tropics, by the Hon. Francis Watts (Leeward Islands); on rubber planting in the West Indies, by Mr. J. H. Hart (Trinidad); pine-apple cultivation at Antigua, by the Hon. Francis Watts (Leeward Islands); the marine resources of the West Indies, by Dr. J. E. Duerden (Jamaica); bee-keeping, by Mr. W. K. Morrison, the acting bee expert of the Department; the cultivation of onions at Antigua, by Mr. Wm. Sands; zebra cattle in Trinidad, by Mr. J. H. Hart and Mr. C. W. Meaden; artificial drying of cacao, by Mr. G. Whitfield Smith; and experiments on the treatment of insect pests in 1900, by Mr. H. Maxwell Lefroy. These papers, together with the discussions that followed them, will be produced in the *West Indian Bulletin*, the official organ of the Imperial Agricultural Department for the West Indies.

The Chemical Section of the Conference, adjourned from the previous year, drew up a report dealing chiefly with uniformity of records in reports upon sugar cane experiments. The Educational Section held a meeting to consider matters connected with the teaching of agriculture in elementary and first grade schools, including the compilation of teachers' handbooks.

J. P. D'ALBUQUERQUE.

NATIONAL ASPECTS OF SCIENTIFIC INVESTIGATION.

AS a rule, the recognition of scientific work by the State is the last matter with which men of science concern themselves. Their work is sufficient for them, and they are content with the results obtained, whether appreciated or not at the proper value to the commonwealth; they are the victors, but they leave the spoils to others. Most true investigators are inspired by this unselfish sentiment, rather than by the desire for personal profit, and all they ask for is the adequate provision of means for research. Even this request is not urged with the persistency necessary to produce effect. It must be remembered that the general public, as well as the persons who have it in their power to encourage investigation by granting subsidies and extending other facilities, do not understand the fundamental importance to the nation of contributions to the store of natural knowledge. When they appreciate the fact that scientific work furnishes the motive power of industrial progress, they will regard it in a more serious and liberal spirit than at present. For this reason no opportunity should be lost of reminding the State of its duties and responsibilities as regards scientific work, the claims of which are not urged with sufficient force by the men engaged in it. Scientific societies and associations in Great Britain interest themselves in the advancement of natural knowledge, but it might be well occasionally to hold a meeting for the purpose of stating some of the relationships between research and national welfare. Such a meeting was held recently at Baltimore, by the American Society of Naturalists, and addresses on the attitude of the State toward scientific investigation were given by Prof. H. F. Osborn, Prof. W. Bullock Clark, Dr. L. O. Howard, Dr. B. T. Galloway and Prof. W. T. Sedgwick. The following extracts from the remarks made upon this occasion are abridged from the report in *Science*.

In the course of the remarks with which the discussion was opened, Prof. H. F. Osborn said:—

A fair criterion of intelligence in the government of a country is afforded by an examination of its annual budget. There is first the provision for a certain number of expenditures which are purely conservative, because the State must maintain itself, it must defend itself, it must support a large class of office-holders who are more or less useful. These expenditures may be wisely and honestly made, but they largely go to waste; they are either immediately productive or altogether non-productive. On the other hand, there are expenditures in the nature of investments, looking to the future and characterising the most far-sighted statesmanship. Conspicuous among these are the funds invested in education and science.

Said Helmholtz in 1862: "In fact men of science form, as it were, an organised army, labouring on behalf of the whole nation, and generally under its direction and at its expense, to augment the stock of such knowledge as may serve to promote industrial enterprise, to increase wealth, to adorn life, to improve political and social relations, and to further the moral development of individual citizens. After the immediate practical results of their work we forbear to inquire; that we leave to the uninstructed. We are convinced that whatever contributes to the knowledge of the forces of nature or the powers of the human mind is worth cherishing, and may, in its own due time, bear practical fruit, very often where we should least have expected it."

Of European countries Germany places in its budget the largest productive investments of this kind; France is not far behind, England is perhaps fourth and affords a conspicuous

example of blindness and fatuity in the matter of unproductive investment; she has, it is true, established textile schools, but has not sufficiently supported technical schools; the cost of a single battleship would establish four splendidly equipped technical schools; England secures the ship and postpones the construction of the schools. All this is through no fault of her prophets of science, who have been as persistent as Jeremiah in foretelling the consequences which are sure to follow.

Yet England gave Darwin his schooling upon the *Beagle*; and Huxley secured his upon the *Rattlesnake*. As a seafaring nation, marine zoology appeals to her imagination, and the single notable departure from her short-sighted policy in the encouragement of pure science is the magnificent service she has rendered in the *Challenger* expedition. Our own Dana was trained upon the Wilkes expedition; the French Government equipped the *Talisman*; the German Government is supporting the highly successful cruise of the *Valdivia* and its publications under Chun; the U.S. Government has a permanent exploring vessel in the *Albatross*.

In this rivalry of foresightedness the German and French Governments have been our keenest competitors both on sea and land, and have probably surpassed us in the recognition of the ultimate economy of pure research. Germany's most admirable recent action is the subvention of Prof. Abbe for his investigations upon optics. Abbe's work was not in the nature of invention, but of research and discovery in the highest sense, resulting in the production of an illuminating stage, apochromatic and achromatic immersion lenses, which have fairly revolutionised biology. What we owe to these lenses in a theoretical sense could not be stated in a single volume, and the economic value is equally immeasurable.

The distinctive feature of pure science is that it is not remunerative; the practical rewards and returns are not the immediate objects in view. On the other hand, the work of Tyndall and Pasteur on fermentation, pursued in the first instance for its own sake, has come to have an economic importance which is simply incalculable.

American legislators have lent a willing ear to the advice of wise men. What we now enjoy we owe mainly to the counsels of Joseph Henry, Spencer F. Baird and G. Brown Goode. And I may call attention here to a thought which will be expanded presently, namely, that the secret of the success of these men is to be found in their enthusiasm, unselfishness and lofty scientific and personal character. When we consider the liberal appropriations made year after year for the United States Geological Survey, the nobly equipped station at Wood's Holl, the purely scientific work which is now being supported by many States and municipalities, there is abundant cause for congratulation. . . .

Prof. W. Bullock Clark dealt chiefly with the power of legislators, cooperation between national bureaux and University institutions and the preparation of men by universities for State work. He said:—

It may perhaps be desirable to examine for a moment the reason why scientific investigation is not and cannot be self-supporting. This may be found in the fact that the great majority of scientific researches have no immediate commercial value and as commodities cannot find a speedy or, in most instances probably, even a prospective market. We all know of many investigations, begun without thought of pecuniary advantage, that have ultimately produced practical results of the greatest importance. Instances might be cited of investigations the value of which were not apparent until a generation or more had passed, as, for example, palæontological researches which have laid the foundation for the correlation of deposits of great economic value. The support of such investigations must be looked upon as investments for the State which no far-sighted statesman will ignore.

We find that ever since the establishment of universities and seminaries widely over Europe in the fourteenth and fifteenth centuries, the civilised countries of the world have recognised in one form or another the relation of the State to scientific investigation. Not only the great nations of the world, but oftentimes the small and relatively poor countries like Belgium and Switzerland, as well as the smallest of our own commonwealths, have frequently provided liberally for the support of scientific research. This has been accomplished through the publicly endowed educational institutions, through the public museums and through the special bureaux of the Government.

Too frequently scientific investigation has held a subordinate place in both the publicly and privately endowed institutions, their chief functions being either educational or commercial. The purpose of the schools and universities is primarily in most instances the instructing of youth in the already acquired results of scientific research rather than the fostering of investigation for itself, although the latter as a secondary consideration often holds a prominent place in the larger institutions of learning. The museums and scientific bureaux are, like our great universities, centres of research, without the exactions of teaching, where continuous investigation can be pursued under most favourable conditions, although here again either educational or commercial considerations for the most part ostensibly control. That this is not always the case is cause for congratulation, and the support of research directly for itself without other, and oftentimes false, claims is becoming yearly a more fully recognised fact.

It is interesting for us who are Americans to know that the claims of science received recognition at the very inception of our Government, for we find that George Washington in his first message to Congress stated: "Nor am I less persuaded that you will agree with me in opinion that there is nothing more deserving your patronage than the promotion of science and literature. Knowledge in every country is the surest basis of public happiness. In one in which the measures of government receive their impressions so immediately from the sense of the community as ours it is proportionately essential." How well that early advice has been carried out by the statesmen of later days under the wise counsels of Henry, Baird, Goode and their successors, Prof. Osborn has already shown. . . .

The various bureaux and divisions of the U.S. Department of Agriculture, the U.S. Geological Survey and the U.S. Coast and Geodetic Survey are all manifesting a broad spirit of helpfulness that is being met by the State and university institutions. The possibilities of an extension of this co-operation between Nation, State and University promise well for the widening of the bounds of scientific investigation in this country. It is indeed a hopeful sign when we see the scientific men of the nation, whatever their affiliations, working together with mutual interest and respect. May it presage the dawn of a still brighter day in American science.

Dr. L. O. Howard spoke more particularly upon the ultimate practical importance of pure scientific work from the point of view of applied entomology, and the preparation of men for the scientific work of the State. He said:—

It is upon work in pure science that the entire superstructure of economic entomology has been built, and workers in applied science are constantly making use of the results of the labours of workers in pure science. The practical outcome, however, of the labours of the workers in pure science is indirect, while the practical outcome of those who work in the economic applications of science is direct. In any emergency the direct method is the one which is immediately productive of practical results. The study of economic entomology is a study of facts which will enable us to meet one great and widely extended emergency. It must be conducted by the direct method, and the reason why this country stands in advance of the rest of the world in this application of science is because we are a practical people and have adopted the direct method. There can be no doubt, however, that it is necessary for the most successful economic worker to have had a sound training in pure science. . . .

Men in charge of university departments of scientific work should keep closely in touch with the Government work along similar lines. They should be encouraged to do this by the Government. Government should employ their services wherever they can be of use, and such cases are numerous. They themselves should be able, with the intimate knowledge acquired by official association or by close investigation of Government work, to lay out lines of study which will fit their students to take a hand in Government work. In many cases, of course, this cannot be thoroughly done in university laboratories at the present time. . . .

The U.S. Department of Agriculture is the first of the Government bureaux which does economic zoological work. Good research work and initiative in investigation are encouraged. Nothing could be more ideally perfect than the relation between the present head of the Department of Agriculture and his scientific corps. Four years ago he announced his policy in this regard in conversation with one of his scientific chiefs in the following words:—"I am here to facilitate your work, not to dictate to you. Make your plans, conduct your investigations,

and I will help you with all my strength, but I shall hold you responsible for results." Scientific men should honour James Wilson for the introduction of this novel principle in the administration of a Government scientific bureau . . . .

The old popular idea of a scientific man—that he lacks what is called "common sense," that he is unpractical—is an unfortunate estimate gained from unappreciative observation of workers in pure science, but it no longer holds. Henry, Agassiz, Baird—all men of affairs, now gone—did much to change this popular estimate, and the host of brilliant men who have succeeded them—men of high scientific rank, who control the destinies and shape the policies of great institutions, and who turn out work of great and important practical value—have demonstrated beyond the slightest doubt that scientific men are the broadest men of affairs, that they are practical men, and that they are fit to be leaders, not only in thought, but in action.

It is doubtful whether any Government in existence does as much for the encouragement and development of science as does our own. This has repaid her a thousandfold, and the sound judgment of the American people and their patriotic pride in national attainment will effect a steady increase in governmental support of scientific work in spite of temporary checks. With scientific men, however, must come the initiative. They must point out the needs and the ways and means by which these needs must be supplied.

Dr. B. T. Galloway spoke as follows:—

Is it not true that the attitude of the State toward science and scientific research is at all times greatly influenced by the shaping of public sentiment through the work of scientific men themselves? This is a practical age, and in America especially the tendency is more and more to give a practical trend to almost every line of research. We find, therefore, as a matter of fact, that there is a general lack of interest in, and support of, matters having to do with pure science alone, while on the other hand all questions having practical application, and even those in which the practical end is remote, are received with commendable liberality. Taking the field of botany, for example, it would be difficult, if not impracticable, to secure support for the preparation and publication of purely floristic monographs, unless it could be pretty clearly shown that such a project had some practical end in view.

In so far, therefore, as the attitude of the State towards all work of this nature is concerned, there is a great deal of conservatism to be overcome, and this conservatism is especially pronounced where pure science is brought strongly to the front. The reason for this is not far to seek, for its roots lie imbedded in the selfishness of human nature, which, acting through organisation in the shape of government, sees, or thinks it sees, in the aggressiveness of science a menace to existing institutions in some form or other. While science in its nature is aggressive, the men who do most to advance it often lack aggressiveness, and for this reason the far-reaching effect of science as an educational factor at the present time is not fully understood or appreciated.

This brings me more particularly to the main question I wish to raise in this discussion, namely, what should be the attitude of the scientific man toward the cause he represents. I am strongly of the opinion that he owes it to himself and to his work to put forth every legitimate effort to advance the interests of the cause. He should, of course, keep constantly before him the fact that to bring honour and credit to the work he must recognise the duties of life. This will not allow him, however, to sit calmly down and wait for the material things of the world to come to him. The men who have it in their power to aid him are too busy to go out of their way to render help unless that help is sought. . . .

With the distinctly utilitarian sentiment towards science, as pointed out, the question arises as to what stand should be taken by those charged with the guidance of the work with respect to shaping a general policy which will meet the demand for practical ends, and at the same time advance the cause of science to the fullest extent. Extremes must be avoided, for if the tendency is too strong toward pure science, opportunities will be lost through lack of support, and if toward ultra-utilitarianism, science itself will be endangered through the development of false views, erroneous statements and lack of judgment—rocks and reefs that must by all means be avoided. There is always a medium ground, however, where science and practice can each be made to help the other and each be the stronger for the support thus gained. This is the stand, I may say, that is now taken by those charged with most of the work conducted under the auspices of the Government, and which, during the past fifteen years at least, has resulted in a rapid development of all work along broad and safe lines. Most of the departments of the Government, wherein scientific work is carried on, owe their existence to a demand for greater knowledge on problems concerning the interests and welfare of the people. In the early days of this work too much attention was given to a mere diffusion of knowledge without regard to its source, and as a result of this original research did not receive the attention it deserved. In later years, however, the importance of research is becoming more and more appreciated, and as a result the work has increased in strength and now commands the respect it deserves. . . .

Prof. W. T. Sedgwick referred to the attitude of the people toward scientific investigation, and the hindrance inflicted upon scientific research by the tariff upon the requisite books and instruments. He added:—

I have been very much interested to hear the quotation from the "Message of Washington" urging upon our people the importance of promoting scientific investigation and research. I believe that the American people are, in increasing numbers, large-minded enough to look through and beyond the nearer every-day phenomena, and to realise that the promotion of discovery, no less than the promotion of learning, pays in every sense of the word. They perceive that it pays in the highest sense, in the enrichment of intellect and the cultivation of faculty. They perceive also that it pays in the utilitarian sense, in that it gives leadership among the nations of the earth in the applications of science which always follow hard upon the heels of discovery. Prof. Osborn has done well to point out that those nations which support research most liberally are those which are taking the lead in the industrial world to-day.

The barrier between pure and applied science is fading away, because they are constantly drawing nearer together and overgrowing one another. Pure science has given to applied science the fundamental elements of truth, perfection, knowledge and skill. Applied science, on the other hand, has developed so prodigiously as to react favourably upon pure science, furnishing for it rich sustenance and fertile soil in which it may flourish. An hour might well be spent in pointing out, not only the aid which pure science has given to applied science, but reciprocally the enormous development of pure science and scientific investigation wrought by applied science. It is one of the marvels of the day that many highly organised and differentiated industries, and even many of the coarser arts, find their narrow but sufficient basis of profit in the employment of the results of the latest and most advanced researches in pure science.

Our age has been called by one of the speakers who has preceded me a practical age, and so it is; but it is an age which has discovered in science the Promethean fire. The highest and truest utilitarianism of to-day is a generous cultivation of scientific investigation, not indeed for its own sake, but for the sake of the results which are sure to follow from it. As to the pursuit of science for its own sake, Prof. Osborn has, it seems to me, used a happy illustration in referring to the scientific investigations of the Government as an investment rather than an immediate outlay for current expenses. As to pure science pursued strictly for its own sake, I think we may rather describe it as an investment from which we still expect ultimately some return. Science for its own sake is, after all, much like investment for its own sake; which has never been made, I fancy, even by the least practical of philanthropists.

For illustration of public appreciation of scientific research as a necessity for practical results, I may give an example. When in 1886 the newly organised State Board of Health of Massachusetts attacked scientifically the problem of protection of the purity of inland waters, they reported to the people of that State that in order to do the work required by the Legislature it would be necessary to inaugurate and prosecute special and novel investigations, and for this and other purposes they asked for an appropriation of 30,000 dollars. This sum was immediately and cheerfully granted by the people for this purpose and has ever since been continued, annually, with the result that the Massachusetts experiments are referred to with commendation and advantage by bacteriologists and engineers all over the world. Again, when it became clear that antitoxin for diphtheria had become a public necessity and its proper preparation a public duty, the same State Board of Health secured the services of one of the most distinguished

bacteriologists in the country, Prof. Theobald Smith, and requested him, not only to prepare antitoxin for the citizens of the State, but also to investigate the best methods of its preparation and preservation, besides other cognate and novel but pressing problems in the field of pure science. Here also the most thorough-going utilitarianism has proved to be scientific investigation pushed to its utmost limits. . . .

THE EFFECT OF PHYSICAL AGENTS ON BACTERIAL LIFE.[1]

THE fact that life did not exist upon the earth at a remote period of time, the possibility of its present existence as well as the prospect of its ultimate extinction, can be traced to the operation of certain physical conditions. These physical conditions upon which the maintenance of life as a whole depends are in their main issues beyond the control of man. We can but study, predict and, it may be, utilise their effects for our benefit. Life in its individual manifestations is, therefore, conditioned by the physical environment in which it is placed. Life rests on a physical basis, and the main springs of its energies are derived from a larger world outside itself. If these conditions, physical or chemical, are favourable, the functions of life proceed; if unfavourable, they cease—and death ultimately ensues. These factors have been studied and their effects utilised to conserve health or to prevent disease. It is our purpose this evening to study some of the purely physical factors, not in their direct bearing on man, but in relation to much lower forms in the scale of life—forms which constitute in number a family far exceeding that of the human species, and of which we may produce at will in a test-tube, within a few hours, a population equal to that of London. These lowly forms of life—the bacteria—belong to the vegetable kingdom, and each individual is represented by a simple cell.

These forms of life are ubiquitous in the soil, air and water, and are likewise to be met with in intimate association with plants and animals, whose tissues they may likewise invade with injurious or deadly effects. Their study is commonly termed bacteriology—a term frequently regarded as synonymous with a branch of purely medical investigation. It would be a mistake, however, to suppose that bacteriology is solely concerned with the study of the germs of disease. The dangerous microbes are in a hopeless minority in comparison with the number of those which are continually performing varied and most useful functions in the economy of nature. Their wide importance is due to the fact that they ensure the resolution and redistribution of dead and effete organic matter which, if allowed to accumulate, would speedily render life impossible on the surface of the earth. If medicine ceased to regard the bacteria, their study would still remain of primary importance in relation to many industrial processes in which they play a vital part. It will be seen, therefore, that their biology presents many points of interest to scientific workers generally. Their study as factors that ultimately concern us really began with Pasteur's researches upon fermentation. The subject of this evening's discourse, the effect of physical agents on bacterial life, is important not merely as a purely biological question, though this phase is of considerable interest, but also on account of the facts I have already indicated, viz. that micro-organisms fulfil such an important function in the processes of nature, in industrial operations, and in connection with the health of man and animals. It depends largely on the physical conditions to be met with in nature whether the micro-organisms exercise their functions, and likewise whether they die or remain inactive. Further, the conditions favouring one organism may be fatal to another, or an adaptability may be brought about to unusual conditions for their life. To the technologist the effect of physical agents in this respect is of importance, as a knowledge of their mode of action will guide him to the means to be employed for utilising the micro-organisms to the best advantage in processes of fermentation. The subject is of peculiar interest to those who are engaged in combating disease, as a knowledge of the physical agents that favour or retard bacterial life will furnish indications for the preventive measures to be adopted. With a suitable soil and an adequate temperature the propagation of bacteria proceeds with great rapidity. If the primary conditions of soil and an adequate temperature are not present, the organisms will not multiply; they remain quiescent or they die. The surface layers of the soil harbour the vast majority of the bacteria, and constitute the great storehouse in nature for these forms of life. They lessen in number in the deeper layers of the soil, and few or none are to be met with at a depth of 8–10 feet. As a matter of fact, the soil is a most efficient bacterial filter, and the majority of the bacteria are retained in its surface layers and are to be met with there. In the surface soil, most bacteria find the necessary physical conditions for their growth, and may be said to exist there under natural conditions. It is in the surface soil that their main scavenging functions are performed. In the deeper layers, the absence of air and the temperature conditions prove inimical to most forms.

Amongst pathogenic bacteria the organisms of lockjaw and of malignant œdema appear to be eminently inhabitants of the soil. As an indication of the richness of the surface soil in bacteria I may mention that 1 gramme of surface soil may contain from several hundred thousand to as many as several millions of bacteria. The air is poorest in bacteria. The favouring physical conditions to be met with in the soil are not present in the air. Though bacteria are to be met with in the air they are not multiplying forms, as is the case in the soil. The majority to be met with in air are derived from the soil. Their number lessens when the surface soil is moist, and it increases as the surface soil dries. In a dry season the number of air organisms will tend to increase.

Town air contains more bacteria than country air, whilst they become few and tend to disappear at high levels and on the sea. A shower of rain purifies the air greatly of bacteria. The organisms being, as I stated, mainly derived from the surface of the ground, their number mainly depends on the physical condition of the soil, and this depends on the weather. Bacteria cannot pass independently to the air, they are forcibly transferred to it with dust from various surfaces. The relative bacterial purity of the atmosphere is mainly, therefore, a question of dust. Even when found floating about in the air the bacteria are to be met with in much greater number in the dust that settles on exposed surfaces, *e.g.* floors, carpets, clothes and furniture. Through a process of sedimentation the lower layers of the air become richer in dust and bacteria, and any disturbance of dust will increase the number of bacteria in the air.

The simple act of breathing does not disseminate disease germs from a patient; it requires an act of coughing to carry them into the air with minute particles of moisture. From the earliest times great weight has been laid upon the danger of infection through air-borne contagia, and with the introduction of antiseptic surgery the endeavour was made to lessen this danger as much as possible by means of the carbolic spray, &c. In the same connection numerous bacteriological examinations of air have been made with the view of arriving at results of hygienic value. The average number of micro-organisms present in the air is 500–1000 per 1000 litres; of this number only 100–200 are bacteria, and they are almost entirely harmless forms. The organisms of suppuration have been detected in the air, and the tubercle bacillus in the dust adhering to the walls of rooms. Investigation has not, however, proved air to be one of the important channels of infection. The bactericidal action of sunlight, desiccation, and the diluting action of the atmosphere on noxious substances, will always greatly lessen the risk of direct aërial infection.

The physical agents that promote the passage of bacteria into the air are inimical to their vitality. Thus, the majority pass into the air, not from moist, but from dry surfaces, and the preliminary drying is injurious to a large number of bacteria. It follows that if the air is rendered dust-free, it is practically deprived of all the organisms it may contain. As regards enclosed spaces, the stilling of dust and more especially the disinfection of surfaces liable to breed dust or to harbour bacteria are more important points than air disinfection, and this fact has been recognised in modern surgery. In an investigation, in conjunction with Mr. Lunt, an estimation was arrived at of the ratio existing between the number of dust particles and bacteria in the air. We used Dr. Aitken's Dust-counter, which not only renders the dust particles visible, but gives a means of counting them in a sample of air. In an open suburb of London we found 20,000 dust particles in 1 cubic centimetre of air; in a yard in the centre of London about 500,000. The dust contamination we found to be about 900 per cent. greater in the centre of London than in a quiet suburb. In the open air of

[1] Discourse delivered at the Royal Institution by Dr. Allan Macfadyen, Director of the Jenner Institute of Preventive Medicine.

London there was, on an average, just one organism to every 38,300,000 dust particles present in the air, and in the air of a room, amongst 184,000,000 dust particles, only one organism could be detected.

These figures illustrate forcibly the poverty of the air in micro-organisms even when very dusty, and likewise the enormous dilution they undergo in the atmosphere. Their continued existence is rendered difficult through the influence of desiccation and sunlight. Desiccation is one of nature's favourite methods for getting rid of bacteria. Moisture is necessary for their development and their vital processes, and constitutes about 80 per cent. of their cell-substance. When moisture is withdrawn, most bacterial cells, unless they produce resistant forms of the nature of spores, quickly succumb. The organism of cholera air-dried in a thin film dies in three hours. The organisms of diphtheria, typhoid fever and tuberculosis show more resistance, but die in a few weeks or months.

Dust containing tubercle bacilli may be carried about by air currents, and the bacilli in this way transferred from an affected to a healthy individual. It may, however, be said that drying attenuates and kills most of these forms of life in a comparatively short time. The spores of certain bacteria may, on the other hand, live for many years in a dried condition, *e.g.* the spores of anthrax bacilli which are so infective for cattle and also for man (wool-sorter's disease). Fortunately, few pathogenic bacteria possess spores, and, therefore, drying by checking and destroying their life is a physical agent that plays an important *rôle* in the elimination of infectious diseases. This process is aided by the marked bactericidal action of *sunlight*. Sunlight, which has a remarkable fostering influence on higher plant life, does not exercise the same influence on the bacteria. With few exceptions we must grow them in the dark in order to obtain successful cultures; and a sure way of losing our cultures is to leave them exposed to the light of day. Direct sunlight is the most deadly agent, and kills a large number of organisms in the short space of one to two hours; direct sunlight proves fatal to the typhoid bacillus in half an hour to two hours, to the diphtheria bacillus in half an hour to one hour, and to the tubercle bacillus in a few minutes to several hours. Even anthrax spores are killed by direct light in three and a half hours. Diffuse light is also injurious, though its action is slower. By exposing pigment-producing bacteria to sunlight, colourless varieties can be obtained, and virulent bacteria so weakened that they will no longer produce infection. The germicidal action of the sun's rays is most marked at the blue end of the spectrum, at the red end there is little or no germicidal action. It is evident that the continuous daily action of the *sun* along with *desiccation* are important physical agents in arresting the further development of the disease germs that are expelled from the body.

It has been shown that sunlight has an important effect in the spontaneous purification of rivers. It is a well-known fact that a river, despite contamination at a given point, may show little or no evidence of this contamination at a point further down in its course. Buchner added to water 100,000 colon bacilli per cubic centimetre, and found that all were dead after one hour's exposure to sunlight. He also found that in a clear lake the bactericidal action of sunlight extended to a depth of about six feet. Sunlight must therefore be taken into account as an agent in the purification of waters, in addition to sedimentation, oxidation and the action of algæ.

Air or the oxygen it contains has important and opposite effects on the life of bacteria. In 1861 Pasteur described an organism in connection with the butyric acid fermentation which would only grow in the absence of free oxygen. And since then a number of bacteria, showing a like property, have been isolated and described. They are termed anærobic bacteria, as their growth is hindered or stopped in the presence of air. The majority of the bacteria, however, are ærobic organisms, inasmuch as their growth is dependent upon a free supply of oxygen. There is likewise an intermediate group of organisms which show an adaptability to either of these conditions, being able to develop with or without free access to oxygen. Preeminent types of this group are to be met with in the digestive tract of animals, and the majority of disease-producing bacteria belong to this adaptive class. When a pigment-producing organism is grown without free oxygen its pigment production is almost always stopped. For anærobic forms N and H_2 give the best atmosphere for their growth, whilst CO_2 is not favourable and may be positively injurious, as, *e.g.*, in the case of the cholera organism.

The physical conditions favouring the presence and multiplication of bacteria in water under natural conditions are a low altitude, warmth, abundance of organic matter and a sluggish or stagnant condition of the water. As regards water-borne infectious diseases such as typhoid or cholera, their transmission to man by water may be excluded by simple boiling or by an adequate filtration. The freezing of water, whilst stopping the further multiplication of organisms, may conserve the life of disease germs by eliminating the destructive action of commoner competitive forms. Thus the typhoid bacillus may remain frozen in ice for some months without injury. Employment of ordinary cold is not, therefore, a protection against dangerous disease germs.

As regards *electricity*, there is little or no evidence of its direct action on bacterial life, the effects produced appear to be of an indirect character due to the development of heat or to the products of electrolysis.

Ozone is a powerful disinfectant, and its introduction into polluted water has a most marked purifying effect. The positive effects of the electric current may therefore be traced to the action of the chemical products and of heat. I am not aware that any direct action of the X-rays on bacteria has up to the present been definitely proved.

Mechanical agitation, if slight, may favour, and if excessive may hinder bacterial development. Violent shaking or concussion may not necessarily prove fatal so long as no mechanical lesion of the bacteria is brought about. If, however, substances likely to produce triturating effects are introduced, a disintegration and death of the cells follows. Thus Rowland, by a very rapid shaking of tubercle bacilli in a steel tube with quartz sand and hard steel balls, produced their complete disintegration in ten minutes.

Bacteria appear to be very resistant to the action of *pressure*. At 300-450 atmospheres putrefaction still takes place, and at 600 atmospheres the virulence of the anthrax bacillus remained unimpaired. Of the physical agents that affect bacterial life, temperature is the most important. Temperature profoundly influences the activity of bacteria. It may favour or hinder their growth, or it may put an end to their life. If we regard temperature in the first instance as a favouring agent, very striking differences are to be noted. The bacteria show a most remarkable range of temperature under which their growth is possible, extending from zero to 70° C. If we begin at the bottom of the scale we find organisms in water and in soil that are capable of growth and development at zero. Amongst these are certain species of phosphorescent bacteria which continue to emit light even at this low temperature. At the Jenner Institute we have met with organisms growing and developing at 34-40° F. The vast majority of interest to us find, however, the best conditions for their growth from 15° up to 37° C. Each species has a minimum, an optimum and a maximum temperature at which it will develop. It is important in studying any given species that the optimum temperature for their development be ascertained, and that this temperature be maintained. In this respect we can distinguish three broad groups. The first group includes those for which the optimum temperature is from 15-20° C. The second group includes the parasitic forms, viz. those which grow in the living body and for which the optimum temperature is at blood heat, viz. 37° C. We have a third group for which the optimum temperature lies as high as 50-55° C. On this account this latter group has been termed thermophilic, on account of its growth at such abnormally high temperatures—temperatures which are fatal to other forms of life. They have been the subject of personal investigation in conjunction with Dr. Blaxall. We found that there existed in nature an extensive group of such organisms to which the term thermophilic bacteria was applicable. Their growth and development occurred best at temperatures at which ordinary protoplasm becomes inert or dies. The best growths were always obtained at 55-65° C. Their wide distribution was of a striking nature. They were found by us in river water and mud, in sewage, and also in a sample of sea water. They were present in the digestive tract of man and animals, and in the surface and deep layers of the soil as well as in straw and in all samples of ensilage examined. Their rapid growth at high temperatures was remarkable, the whole surface of the culture medium being frequently overrun in from fifteen to seventeeen hours. The organisms examined by us (fourteen forms in all) belonged to the group of the Bacilli. Some were motile, some curdled milk, and some liquefied gelatin in virtue of a proteolytic enzyme.

The majority possessed reducing powers upon nitrates and decomposed proteid matter. In some instances cane sugar was inverted and starch was diastased. These facts well illustrate the full vitality of the organisms at these high temperatures, whilst all the organisms isolated grew best at 55–65° C. A good growth in a few cases occurred at 72° C. Evidence of growth was obtained even at 74° C. They exhibited a remarkable and unique range of temperature, extending as far as 30° of the Centigrade scale.

As a concluding instance of the activity of these organisms we may cite their action upon cellulose. Cellulose is a substance that is exceedingly difficult to decompose, and is therefore used in the laboratory for filtering purposes in the form of Swedish filter paper, on account of its resistance to the action of solvents. We allowed these organisms to act on cellulose at 60° C. The result was that in ten to fourteen days a complete disintegration of the cellulose had taken place, probably into CO_2 and marsh gas. The exact conditions that may favour their growth, even if it be slow at subthermophilic temperatures, are not yet known—they may possibly be of a chemical nature.

Organisms may be gradually *acclimatised* to temperatures that prove unsuited to them under ordinary conditions. Thus the anthrax bacillus, with an optimum temperature for its development of 37° C., may be made to grow at 12° C. and at 42° C. Such anthrax bacilli proved pathogenic for the frog with a temperature of 12° C., and for the pigeon with a temperature of 42° C.

Let us in a very few words consider the inimical action of temperature on bacterial life. An organism placed below its minimum temperature ceases to develop, and if grown above its optimum temperature becomes attenuated as regards its virulence, etc., and may eventually die. The boiling point is fatal for non sporing organisms in a few minutes. The exact thermal death-point varies according to the optimum and maximum temperature for the growth of the organism in question. Thus for water bacteria with a low optimum temperature blood heat may be fatal; for pathogenic bacteria developing best at blood heat, a thermophilic temperature may be fatal (60° C.); and for thermophilic bacilli any temperature above 75° C. These remarks apply to the bacteria during their multiplying and vegetating phase of life. In their resting or spore stage the organisms are much more resistant to heat. Thus the anthrax organism in its bacillary phase is killed in one minute at 70° C.; in its spore stage it resists this temperature for hours, and is only killed after some minutes by boiling. In the soil there are spores of bacteria which require boiling for sixteen hours to ensure their death. These are important points to be remembered in sterilisation or disinfection experiments, viz. whether an organism does or does not produce these resistant spores. Most non-sporing forms are killed at 60° C. in a few minutes, but in an air-dry condition a longer time is necessary. Dry heat requires a longer time to act than moist heat: is requires 140° C. for three hours to kill anthrax spores. Dry heat cannot, therefore, be used for ordinary disinfection on account of its destructive action. Moist heat in the form of steam is the most effectual disinfectant, killing anthrax spores at boiling point in a few minutes, whilst a still quicker action is obtained if saturated steam under pressure be used. No spore, however resistant, remains alive after one minute's exposure to steam at 140° C. The varying thermal death-point of organisms and the problems of sterilisation cannot be better illustrated than in the case of milk, which is an admirable soil for the growth of a large number of bacteria. The most obvious example of this is the souring and curdling of milk that occurs after it has been standing for some time. This change is mainly due to the lactic acid bacteria, which ferment the milk sugar with the production of acidity.

Another class of bacteria may curdle the milk without souring it in virtue of a rennet-like ferment, whilst a third class precipitate and dissolve the casein of the milk, along with the development of butyric acid. The process whereby milk is submitted to a heat of 65° to 70° C. for twenty minutes is known as pasteurisation, and the milk so treated is familiar to us all as pasteurised milk. Whilst the pasteurising process weeds out the lactic acid bacteria from the milk, a temperature of 100° C. for one hour is necessary to destroy the butyric acid organisms: and even when this has been accomplished there still remain in the milk the spores of organisms which are only killed after a temperature of 100° C. for three to six hours. It will, therefore, be seen that pasteurisation produces a partial, not a complete sterilisation of the milk as regards its usual bacterial inhabitants. The sterilisation to be absolute would require six hours at boiling point. But for all ordinary practical purposes pasteurisation is an adequate procedure. All practical hygienic requirements are likewise adequately met by pasteurisation, if it is properly carried out and the milk is subsequently cooled. Milk may carry the infection of diphtheria, cholera, typhoid and scarlet fevers as well as the tubercle bacillus from a diseased animal to the human subject. For the purpose of rendering the milk innocuous, freezing and the addition of preservatives are inadequate methods of procedure. The one efficient and trustworthy agent we possess is heat. Heat and cold are the agents to be jointly employed in the process, viz. a temperature sufficiently high to be fatal to organisms producing a rapid decomposition of milk, as well as to those which produce disease in man; this to be followed by a rapid cooling to preserve the fresh flavour and to prevent an increase of the bacteria that still remain alive. The pasteurising process fulfils these requirements.

In conjunction with Dr. Hewlett, I had occasion to investigate in how far the best pasteurising results might be obtained. We found that 60° to 68° C. applied for twenty minutes weeded out about 90 per cent. of the organisms present in the milk, leaving a 10 per cent. residue of resistant forms. It was found advisable to fix the pasteurising temperature at 68° C. in order to make certain of killing any pathogenic organisms that may happen to be present. We passed milk in a thin stream through a coil of metal piping, which was heated on its outer surface by water. By regulating the length of the coil, or the size of the tubing, or the rate of flow of the milk, almost any desired temperature could be obtained. The temperature we ultimately fixed at 70° C. The cooling was carried out in similar coils placed in iced water. The thin stream of milk was quickly heated and quickly cooled as it passed through the heated and cooled tubing, and, whilst it retained its natural flavour, the apparatus accomplished at 70° C. in thirty seconds a complete pasteurisation, instead of in twenty minutes, *i.e.* about 90 per cent. of the bacteria were killed, whilst the diphtheria, typhoid, tubercle and pus organisms were destroyed in the same remarkably short period of time, viz. thirty seconds. This will serve to illustrate how the physical agent of heat may be employed, as well as the sensitiveness of bacteria to heat when it is adequately employed.

Bacteria are much more sensitive to high than to low temperatures, and it is possible to proceed much further downwards than upwards in the scale of temperature, without impairing their vitality. Some will even multiply at zero, whilst others will remain alive when frozen under ordinary conditions.

I will conclude this discourse by briefly referring to experiments recently made with the most remarkable results upon the influence of low temperatures on bacterial life. The experiments were conducted at the suggestion of Sir James Crichton-Browne and Prof. Dewar. The necessary facilities were most kindly given at the Royal Institution, and the experiments were conducted under the personal supervision of Prof. Dewar. The action of liquid air on bacteria was first tested. A typical series of bacteria was employed for this purpose, possessing varying degrees of resistance to external agents. The bacteria were first simultaneously exposed to the temperature of liquid air for twenty hours (about −190° C.). In no instance could any impairment of the vitality of the organisms be detected as regards their growth or functional activities. This was strikingly illustrated in the case of the phosphorescent organisms tested. The cells emit light which is apparently produced by a chemical process of intracellular oxidation, and the phenomenon ceases with the cessation of their activity. These organisms, therefore, furnished a very happy test of the influence of low temperatures on vital phenomena. These organisms when cooled down in liquid air became non-luminous, but on re-thawing the luminosity returned with unimpaired vigour as the cells renewed their activity. The sudden cessation and rapid renewal of the luminous properties of the cells despite the extreme changes of temperature was remarkable and striking. In further experiments the organisms were subjected to the temperature of liquid air for seven days. The results were again *nil*. On re-thawing the organisms renewed their life processes with unimpaired vigour. We had not yet succeeded in reaching the limits of vitality. Prof. Dewar kindly afforded the opportunity of submitting the organisms to the temperature of liquid hydrogen—about −250° C. The same series of organisms was employed, and again the result was *nil*. This temperature is only 21° above that of the absolute zero, a

temperature at which, on our present theoretical conceptions, molecular movement ceases and the entire range of chemical and physical activities with which we are acquainted either cease or, it may be, assume an entirely new *rôle*. This temperature, again, is far below that at which any chemical reaction is known to take place. The fact, then, that life can continue to exist under such conditions affords new ground for reflection as to whether, after all, life is dependent for its continuance on chemical reactions. We, as biologists, therefore follow with the keenest interest Prof. Dewar's heroic attempts to reach the absolute zero of temperature; meanwhile his success has already led us to reconsider many of the main issues of the problem. And by having afforded us a new realm in which to experiment, Prof. Dewar has placed in our hands an agent of investigation from the effective use of which we who are working at the subject at least hope to gain a little further insight into the great mystery of life itself.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The election to the vacancy on the Council of the Senate, caused by the resignation of Bishop Ryle, will take place on February 8.

Mr. Stanley Gardiner has presented to the University an ethnological collection of 300 objects from the Maldives and Minikoi. The collection contains many valuable specimens.

Mr. W. N. Shaw, F.R.S., Secretary to the Meteorological Council, will give in the Cavendish laboratory a course of four lectures on the Physics of the Atmosphere, at 4.30, on February 7, 14, 21, and 28.

The Special Board for Biology recommend that the annual grant of 100*l.* shall be made by the University to Dr. Dohrn's Zoological Station at Naples for a further period of five years.

The Senate has sanctioned the obtaining of specifications and tenders for the erection of the Humphry Museum as a portion of the new Medical School Buildings.

THE following appointments have recently been made at the Jenner Institute of Preventive Medicine:—Dr. S. G. Hedin, of the University of Lund, Sweden, has been appointed head of the department of pathological chemistry; Mr. J. Beresford Leathes, lecturer in physiology at St. Thomas's Hospital Medical School, assistant in the same department; and Mr. W. J. Young, of the Owens College, Manchester, assistant in the chemical department. Drs. Moore, Petrie and Mackenzie have been elected to fill the three research studentships, the last-named gentleman being appointed to the Grocers' Company research studentship of the Jenner Institute.

AT the meeting of the London County Council on Monday, the Chairman announced that a letter had been received from Mr. Horniman, a member of the Council, offering on behalf of his father, Mr. Horniman, M.P., to the people of London a gift of great value, probably representing from 50,000*l.* to 100,000*l.* The letter was as follows:—"Dear Mr. Dickinson,—I have been empowered by my father, Mr. Horniman, M.P., who is now travelling in the East, to offer as a free gift to the people of London some fifteen acres of freehold land, together with the museum which has just been erected at the cost of about 40,000*l.* In it are placed the large art and natural history collections gathered by Mr. Horniman during the last twenty-five years. The property is situated close to Lordship Lane Station on the South Eastern and Chatham Railway and about three-quarters of a mile from Forest Hill Station on the London, Brighton and South Coast Railway. It consists of:—(1) A large house known as Surrey Mount and some nine and a half acres of pleasure grounds on the summit and slope of a hill commanding extensive views over south-eastern and south-western London. The site is a suitable one for a park or recreation ground, and has been open to the public during the summer months for four years. Over 200,000 persons visited it during fourteen months in 1897 and 1898. (2) The museum, a stone building 258 ft. long by 61 ft. wide, with a superficial area of 16,485 square feet. (3) Six residences, occupying some 5¼ acres of ground, now let on leases of diverse terms and bringing in an income of about 600*l.* per annum, which could be used for the maintenance of the museum until the tenancies fall in, when the land could be added to the recreation ground and additions made to the museum if necessary. There is also a library of 5,500 volumes of travel, natural history, &c., and a Biblical library of 700 volumes, containing many early and rare editions. Notwithstanding the very inadequate way in which the collections were formerly housed, and the fact that they were open to the public on but two or three days a week, over 455,000 persons visited them in four years, averaging 660 per day in the last year. Mr. Horniman considers the time has now arrived when the museum and adjoining property will be more useful if vested in a public body, and he has much pleasure in offering the same to the London County Council as a place of public recreation and instruction. Beyond a condition that the museum and grounds are to be maintained in a proper condition and dedicated to the public for ever there are few or no conditions attached to the proposed gift, and I am sure there are none that the Council could not readily accept.—Yours faithfully, Emslie John Horniman." It was resolved that the offer be accepted, and that the thanks of the Council be conveyed to Mr. Horniman for his munificent gift.

SCIENTIFIC SERIAL.

Wiedemann's Annalen der Physik, January.—Double refraction in glass plates vibrating transversely, by W. Konig. In a long glass plate or rod vibrating transversely, there is at the nodes double refraction of a peculiar kind. This has been subjected to a detailed experimental study, and the results discussed fully from the theoretical point of view. The author has been successful in obtaining photographic records of these phenomena, copies of which accompany the paper.—On the tones produced by vibrating sheets of gas in flames, by V. Henson. A photographic study of vibrating flames.—On the absorption of light in coloured glass, by R. Zgismondy. The colour of a glass, and hence its absorption spectrum, depends, not only upon the nature of the colouring material present, but also upon the composition of the colourless glass itself. Experiments were therefore carried out with twelve glasses of different composition, varying from pure sodium and potassium silicate on the one hand to pure lead silicate on the other. Borax and fused boron trioxide were also examined. The colouring oxides included the oxides of copper, chromium, cobalt, nickel, manganese, iron and uranium. For these glasses the constant $A = E/gS$ was determined, where S is the specific gravity of the glass, g the number of milligrams of the colouring oxide per gram of glass, and E the extinction coefficient. The results are expressed graphically.—On the decrement of the electrical vibrations on the charging of condensers, by A. F. Sundell and Hj. Tallqvist. Although in many researches on damped vibrations the experimental figures for the time of oscillation agree well with those deduced theoretically, in the case of the decrement of these vibrations the agreement is either very rough, or there is no agreement at all. In the present series of experiments it is shown that if the necessary corrections are introduced, the experimental and theoretical results agree exactly.—On the melting point of gold, by L. Holborn and A. Day (see p. 330).—On the expansion of some metals at high temperatures, by L. Holborn and A. Day. The coefficients of expansion of platinum, palladium, silver, 20 per cent. platinum-iridium nickel, constantin, wrought iron and steel were determined for temperatures between 0° and 1000° C., where the melting-points allowed.—On the irregularity of the Weston cadmium element with 14·3 per cent. amalgam in the neighbourhood of 0° C., by W. Jaeger. It is shown that in the neighbourhood of 0° C. the irregular variations of this cell may amount to as much as two millivolts, although at 10° C. different elements agree to within a few tenths of a millivolt.—Communication to the knowledge of the phenomena in induction apparatus, by K. K. Johnson.—On surface tension, by H. Hulshof. The necessary existence of surface tension is deduced from the assumption of a continuous density variation in the capillary layer.—On the numerical relation between the two elasticity constants in isotropic media, according to the molecular theory, by W. Voigt.—On the electrical analogue to the Zeeman effect, by W. Voigt.—On the change of the form of vibration of light when propagated through a dispersive and absorbing medium, by W. Voigt.—Calculation of the conductivity of gases, by J. Stark.—A criticism of the mode of derivation of Wien's spectrum equation, by E. Jahnke, O. Lummer and E. Pringsheim.—On the history of telegraphy, by L. Lewin.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 17.—"The Thermo-chemistry of the Alloys of Copper and Zinc," by T. J. Baker, King Edward's School, Birmingham. Communicated by Prof. Poynting, F.R.S.

The heats of formation of a number of alloys of copper and zinc have been ascertained by measuring the difference between the heats of dissolution, in suitable solvents, of each alloy and of an equal weight of a mere mixture containing the metals in the same proportion.

The following solvents were employed:—

(*a*) An aqueous solution of chlorine.

(*b*) A mixture of ammonium chloride and ferric chloride solutions.

(*c*) A mixture of ammonium chloride and cupric chloride solutions.

The first solvent did not give satisfactory results, although it showed that the heat of dissolution of an alloy was sensibly less than that of the corresponding mixture.

Solvents *b* and *c* were found to be very suitable; the chemical actions concerned are simple reductions, and no gases are evolved.

Two series of experiments made on twenty-one alloys yielded very concordant results.

A sharply defined maximum heat of formation is found in the alloy containing 32 per cent. of copper, *i.e.* corresponding to $CuZn_2$. It amounts to 52·5 calories per gramme of alloy, or 10,143 calories per gramme-molecule. There is some evidence of a sub-maximum in the alloy corresponding to CuZn.

From these points there is a steady decrease in the heat of formation, both in the case of alloys containing less than 32 per cent. of copper as the quantity of copper decreases, and also in the case of those containing more than 50 per cent. of copper as the amount of copper increases.

The results, in general, confirm the existence of intermetallic compounds, and the values obtained are in accordance with those demanded by Lord Kelvin's calculation of the molecular dimensions of copper and zinc.

Royal Microscopical Society, January 16.—Annual Meeting. William Carruthers, Esq., F.R.S., President, in the chair.—Mr. Hugh M. Leake exhibited a new form of rocking microtome, designed to cut perfectly flat sections. Dr. Hebb said it seemed to remedy the defects of the ordinary Cambridge rocker, it appeared to be easily manipulated and was very stable and solid in construction.—Dr. Hebb read the report of the council for the year 1900.—The president announced that the whole of the Fellows nominated for officers and council had been duly elected, and expressed his thanks to the Fellows of the Society for again placing him in the position which he had occupied during the past year. He congratulated the Society upon the improved conditions indicated in the report. He then read the annual address, which consisted chiefly of an epitome of the life and work of John Ellis, known in his time as "Coralline Ellis."

Mineralogical Society, January 22.—Prof. A. H. Church, F.R.S., President, in the chair.—Dr. C. O. Trechmann contributed a note on an occurrence of colourless, water-clear mirabilite in gypsum-rock from Kirkby Thore in Westmoreland.—Mr. Alfred Harker discussed a question relative to extinction-angles in rock-slices. A rhombic crystal gives straight extinction in any section parallel to a bisectrix. The author has investigated the degree of departure from straight extinction introduced by a slight obliquity in the direction of section, and finds that no serious error can result unless the angle between the optic axes (measured over the bisectrix in question) is a very large one.—Prof. Lewis communicated an additional note by Mr. R. W. H. T. Hudson on the rotation of points and planes about an axis. Mr. W. Barlow exhibited a model showing an arrangement for the chemical atoms of calcite, which gives the observed crystal-symmetry and is capable of artificial twinning. He explained that the indiarubber balls forming the model are intended to show spherical spheres of influence of the atoms, and that he had arrived at the relative magnitudes which should be used by a geometrical study of elementary stereochemical properties of the carbon compounds. Such models are not supposed to throw any light on the actual forms of the chemical atoms, but are consistent with the supposition that each of these is in motion about a geometrical centre, provided that the centre retain a definite relative situation with respect to the centres belonging to other surrounding atoms. In this, like the stereochemists, he lays stress on the space arrangement of the atoms within the molecule. Mr. H. B. Hartley exhibited a device to facilitate the separation of minerals by means of heavy liquids.

PARIS.

Academy of Sciences, January 28.—M. Fouqué in the chair.—The production of hydrogen in the igneous rocks, by M. Armand Gautier. In seeking for the cause of the development of free hydrogen from granitic rocks at a red heat, it was found that hydrogen is evolved when steam is passed over red-hot ferrous salts. The reaction with ferrous sulphide was carefully studied, and found to be in accordance with the equation $3FeS + 4H_2O = Fe_3O_4 + 3H_2S + H_2$. Various rocks, after a preliminary extraction of the occluded gases by heating in a vacuum, gave, on further heating in a current of steam, a mixture of hydrogen, methane and carbon-monoxide.—The expenditure of energy necessitated by motor work and resisting work in man when raising or lowering himself on Hirn's wheel. The evaluation from the oxygen absorbed in the respiratory exchanges, by M. A. Chauveau.—The permanent secretary announced to the Academy the loss it had sustained by the death of M. J. G. Agardh, correspondant in the Section of Botany.—Diverse positions of the neutral fibre in bodies broken by flexure; the cause of fragility, by M. Ch. Frémont. In discussing the experiments of Mr. Hadfield on the mechanical properties of the iron-nickel alloys, it is shown that these results are in accordance with the views previously put forward by the author.—On the propagation of the Hertzian waves in wireless telegraphy, by M. E. Lagrange. From some experiments described, in which the wire emitting the waves was entirely underground, it is concluded that the waves do not penetrate the interior of the earth, and that there is probably absorption and reflection of the waves emitted in the ordinary way.—A study of uranium nitrate, by M. Œchsner de Coninck.—Action of boron bromide upon the iodides of phosphorus and upon the halogen compounds of arsenic and antimony, by M. Tarible. The halogen compounds of phosphorus form double compounds with one or two molecules of boron bromide. The chlorides of arsenic and antimony give an ordinary double decomposition, the bromides and iodides, on the other hand, simply going into solution without any reaction taking place.—Action of œnanthylic alcohol upon its sodium derivative; a new method of synthesis for the alcohols, by M. Marcel Guerbet. As a result of the action of œnanthylic alcohol upon its sodium derivative there is produced œnanthylic acid, di-œnanthylic alcohol, triœnanthylic alcohol, and the corresponding acid.—Direct hydrogenation in presence of reduced nickel; the preparation of hexahydrobenzene, by MM. Paul Sabatier and J. B. Senderens (see p. 354).—On the mechanism of diastatic actions, by M. Hanriot. Further experiments are brought forward in support of the hypothesis that the action of lipase is a reversible one, and it is pointed out that this reversibility is not an isolated fact, a similar action having been already indicated by Hill in the reaction of maltose and glucose. These results modify the views now held as to the function of the internal ferments in the organism.—Researches on fibrinolysis, by M. L. Camus. Immunity can be produced by injecting into the vessels substances in suspension in a 0·8 per cent. solution of salt. Injections of fibrin do not determine the production of a fibrinolytic serum, and the normal serum may dissolve the precipitate caused by the serum of an immunised animal.—On the relations of the Gregarians and the intestinal epithelium, by M. Michel Siedlecki. *Monocystis ascidiae* passes the greatest portion of its period of growth altogether in a cell of the intestinal epithelium of a Tunicate, *Ciona intestinalis*, even in its earliest stages, the Gregarian has the characters of the adult animal, simply increasing in size as its grows.—Intracellular parasitism and the asexual multiplication of the Gregarians, by MM. Maurice Caullery and Félix Mesnil. It is shown that there is a great variety of relations between these parasites and the intestinal epithelium, there being all degrees of development from a growth entirely extracellular to a completely intracellular development. — On the inversion of the heart in one of the component subjects of a living double monster, by M. Chapot-Prévost. One of the subjects, who died shortly after the separating operation, had the heart normally placed. The other, who survived the operation, was shown by radiography to have the heart inverted. This case of cardiac heterotaxy entirely confirms the ideas of Dareste on the

importance of this phenomenon in teratology.—Remarks by M. Lannelongue on the preceding paper.—On the manna of the olive, by M. Trabut. In the region of Bibans there is a considerable number of olive trees which exude during the summer a very large quantity of manna. On analysis this was found to be identical with the manna from the ash, containing about 52 per cent. of mannite.—Influence of the osmotic pressure of the medium on the form and the structure of vegetables, by M. J. Beauverie. The roots of *Phaseolus*, growing in a concentrated solution, possess no medulla, the differentiation of the ligneous tissue proceeding from the centre. There is also very early produced an abundant pericyclic cork layer, having evidently a protective function as regards the central cylinder. In a root of the same age growing in water there is, on the contrary, a voluminous medulla, and there is no premature production of cork.—On the presence of the genus *Caprina* in the Urgonian, by M. V. Paquier.—On the specific heats of silk, wool and cotton, by M. Testenoire. A reclamation of priority against M. G. Fleury.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part 3, for 1900, contains the following memoirs communicated to the Society :—

June 16.—O. Wallach : I. (1) On the splitting-up of cyclic oximes, (2) hexacyclic ketones, (3) heptacyclic ketones ; II. New syntheses in the terpene series.

June 30.—A. Loewy : On the transformation into itself of a non-vanishing Hermite determinant.

July 14.—E. Riecke : On the relative conductivities of metals for heat and for electricity.—D. Hilbert : Mathematical problems, an address before the International Congress of Mathematicians at Paris, 1900.—R. Fricke : Automorphous elementary forms.

July 28.—R. Fricke : Ritter's prime-form on an arbitrary Riemann surface.—A. Voss : On the principles of Hamilton and of Maupertuis.—W. Nernst and H. Reynolds : On the conductivity of solid mixtures at high temperatures.

October 27.—W. Voigt : On the inductivity of ferromagnetic crystals, with special reference to Weiss's observations on magnetite.—M. Dehn : On equivalent polyhedra (capable of dissection into congruent portions).

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 7.

ROYAL SOCIETY, at 4.30.—The Boiling Point of Liquid Hydrogen, determined by Hydrogen and Helium Gas Thermometers : Prof. Dewar, F.R.S.—On the Brightness of the Corona of January 22, 1898. Preliminary Note : Prof. H. H. Turner, F.R.S.—Preliminary Determination of the Wave-Lengths of the Hydrogen Lines derived from Photographs taken at Ovar at the Eclipse of the Sun, 1900, May 28 : F. W. Dyson.—Investigations on the Abnormal Outgrowths or Intumescences on *Hibiscus vitifolius*, Linn. : a Study in Experimental Plant Pathology : Miss E Dale.—On the Proteid Reaction of Adamkiewicz, with Contributions to the Chemistry of Glyoxylic Acid : F. G. Hopkins and S. W. Cole.—The Integration of the Equations of Propagation of Electric Waves : Prof. Love, F.R.S.

CHEMICAL SOCIETY, at 8.—Ballot for the Election of Fellows—The Action of Hydrogen Bromide on Carbohydrates : H. J. H. Fenton and Mildred Gostling.—Note on a Method of comparing the Affinity-Values of Acids : H. J. H. Fenton and H. O. Jones.—Organic Derivatives of Phosphoryl Chloride, and the Space Configuration of the Valencies of Phosphorus : R. M. Caven.—(1) Synthetical Work with Sodamide Derivatives ; (2) Note on Two Molecular Compounds of Acetamide ; (3) Diacetamide, a New Method of Preparation : Dr. A. W. Titherley.

RÖNTGEN SOCIETY, at 8.—Experiences of X-Ray Work during the Siege of Ladysmith ; Lieut. F. Bruce.

FRIDAY, FEBRUARY 8.

ROYAL INSTITUTION, at 9.—History and Progress of Aërial Locomotion : Prof. G. H. Bryan, F.R.S.

PHYSICAL SOCIETY, at 5.—Annual General Meeting.—Address by the President.—Followed by a paper on Mica Echelon Grating : Prof. R. W. Wood.

ROYAL ASTRONOMICAL SOCIETY, at 3.—Annual General Meeting.

GEOLOGISTS' ASSOCIATION, at 8.—Annual General Meeting.—Twelve Years of London Geology : The President, W. Whitaker, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Cycle Resistance : H. E. Wimperis.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Power-Gas and Large Gas-Engines for Central Stations : H. A. Humphrey.

ANATOMICAL SOCIETY, at 4.30.—The Origin of the Vertebrate Ear and Eighth Pair of Cranial Nerves : W. H. Gaskell, F.R.S.—A Critical Review of Recent Literature on Fossil Anthropoids : W. L. H. Duckworth.

MALACOLOGICAL SOCIETY, at 8.—Annual General Meeting.

MONDAY, FEBRUARY 11.

ROYAL INSTITUTION, at 3.—Origin of Vertebrate Animals : Dr. A. Willey.

SOCIETY OF ARTS, at 8.—The Bearings of Geometry on the Chemistry of Fermentation : W. J. Pope.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—On Her Majesty's Connection with the Society and Interest in Geography, and on Polar Exploration during the Queen's Reign : The President—Progress of Exploration and the Spread and Consolidation of the Empire in America, Australasia, and Africa : Right Hon. Sir George Taubman Goldie, K.C.M.G.—Advances in Asia, and Imperial Consolidation in India : Colonel Sir Thomas H. Holdich, K.C.I.E.

TUESDAY, FEBRUARY 12.

ROYAL INSTITUTION, at 3.—Practical Mechanics : Prof. J. A. Ewing, F.R.S.

SOCIETY OF ARTS, at 8.—Recent Advances in Pottery Decoration : William Burton.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed* : The Present Condition and Prospects of the Panama Canal Works : J. T. Ford.—*Paper to be read, time permitting* : The Nilgiri Mountain-Railway : W. J. Weightman.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Annual General Meeting.

WEDNESDAY, FEBRUARY 13.

SOCIETY OF ARTS, at 8.—Arsenic in Beer and Food : William Thomson.

THURSDAY, FEBRUARY 14.

ROYAL SOCIETY, at 4.30.

MATHEMATICAL SOCIETY, at 5.30.—The Distribution of Velocity and the Equations of the Stream Lines, due to the Motion of an Ellipsoid in Fluid Frictionless and Viscous : T. Stuart—On Factorisable Twin Binomials : Lieut.-Colonel Cunningham, R.E.—Concerning the Abelian and Related Linear Groups : Prof. L. E. Dickson.—A Geometrical Theory of Differential Equations of the First and Second Orders : R. W. Hudson—Brocardal Properties of some Associated Triangles : R. Tucker.

SOCIETY OF ARTS (Indian Section), at 4.30.—The Greek Retreat from India : Colonel Sir Thomas H. Holdich, K.C.I.E.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Capacity in Alternate Current Working : W. M. Mordey. (Adjourned Discussion.)

FRIDAY, FEBRUARY 15.

ROYAL INSTITUTION, at 9.—Electric Waves : Right Rev. Monsignor Gerald Molloy.

GEOLOGICAL SOCIETY, at 3.—Annual General Meeting.

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